■ MODERNIZATION ISSUE ■

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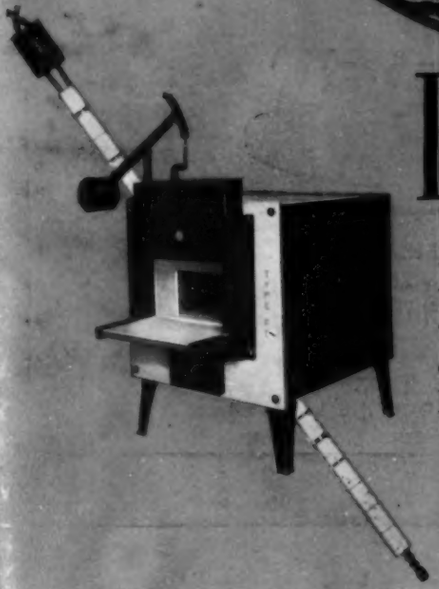

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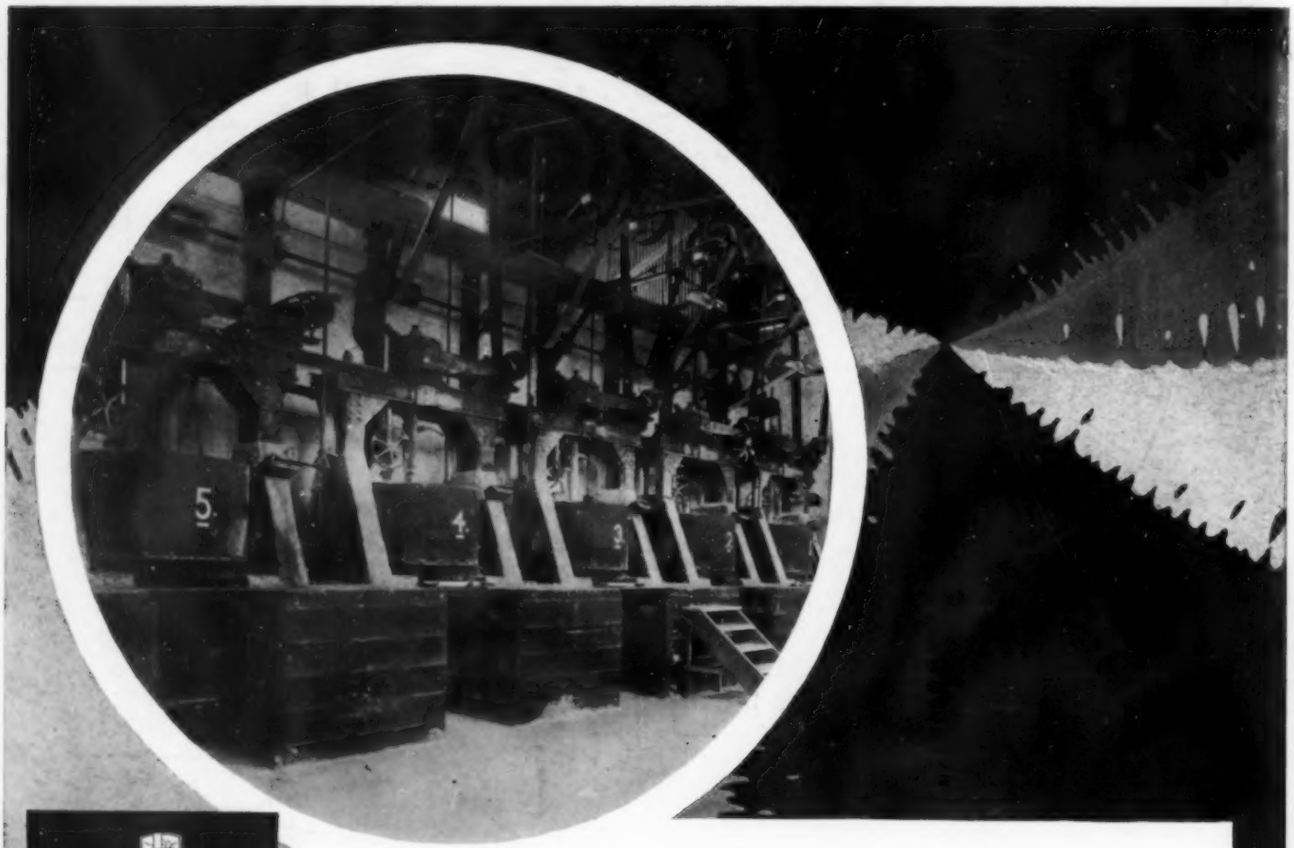

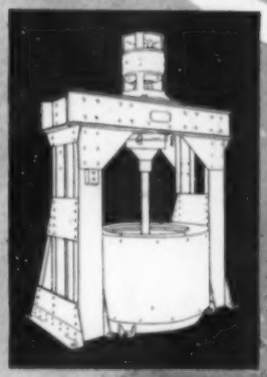

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SEPTEMBER, 1928

McGRAW-HILL PUBLISHING COMPANY, INC. - JAMES H. McGRAW, *President* - EDWARD J. MEHREN, *Vice-President* - H. C. PARMELEE, *Editor*

MODERNIZATION
through
men - methods - materials - machinery

REDUCED to its elements, the efficiency of modern industry is a measure of men and methods, materials and machinery. Only through the productive co-ordination of these elements does a business grow and prosper. Concentration of these forces on such fundamental problems as the improvement of efficiency in production and distribution offers the greatest opportunity for further industrial progress. To contribute to such a basic development and to stimulate its fulfillment, *Chem. & Met.* has, with the generous co-operation of many contributors, prepared in the present issue a well-rounded symposium on the advantages that come from modernization in our industries.

OUR concept of modernization implies first of all an attitude of mind—a positive, receptive willingness on the part of management to accept the new and discard the old before it becomes an encumbrance to industrial progress. In no other field does the threat of obsolescence carry so great a responsibility. The ever-present hazard of change in process and equipment calls for men awake to progress and endowed with fearless enthusiasm for throwing aside precedent and for pioneering into new fields of endeavor.

GIVEN the willingness of the mind to adopt the best in modern practice, there remains the need for accurate knowledge of methods, materials and equipment. These are the physical means toward the objectives of the modernization program. Naturally a considerable proportion of this issue deals with these very practical aspects of chemical engineering.

BUT modernization is concerned not alone with the purely defensive struggle for the competitive survival of the most efficient. It finds equally important application in positive, pace-setting enterprise. Aggressive leadership in the chemical engineering industries comes logically to organizations with men of modern viewpoint, who use materials, methods and machinery representing the highest development of modern technology.

MODERNIZATION *for*

By E. M. ALLEN
President, The Mathieson Alkali Works, Inc., New York, N. Y.

TEN YEARS AGO the signing of the Armistice precipitated problems and responsibilities the seriousness of which many executives and directors of American chemical industries failed to grasp. Only the most alert and far-sighted foresaw, at that time, the long period of intensive world competition and of narrowing margins of profit which was to follow as a natural reaction of war-time conditions. Production of chemicals had become a mad scramble for tonnage, with cost a secondary consideration. Selling had become virtually a lost art. Distribution was largely directed by the Government and the chemical salesmen were either in its employ or had become mere order takers. A mushroom growth of brokers, middlemen, and speculators had disrupted real sales policies and manufacturers had lost close and essential contact with the consumers of their products.

IT TOOK the sobering effects of the deflation period of 1921 to bring the needs for re-adjustment most forcibly to the attention of management in many of our chemical corporations. Solution for the serious post-war economic problems which were then confronted would spell either success or failure for these industries. For most of them but one decision was possible. Production had to be put on the most efficient basis, even if it meant the wholesale scrapping of equipment and the entire remodeling of plants. Sales departments had to be reorganized, and in many cases completely remade, in order to establish the close and direct relations between producer and consumer. Engineering departments had to be augmented and research machinery set in motion to learn the best in modern practice both in this country and abroad.

FINANCING of such enormous modernization programs, particularly at such a time, offered no small problem. Some more fortunate organizations were able to do it from accumulated war profits. With many others, however, it was necessary to cut every possible expense in order to plow back into the business every available dollar of profit. Scant dividends were sometimes paid to the stockholders. In many cases they had to be omitted entirely. Many corporations were forced to raise new money by the issuance of additional securities while many others accomplished the same objective by complete corporate reorganization. Convincing evidence of the wisdom of these large investments in new plants, processes, and equipment is just now beginning to make itself apparent in our present prosperity and the increased earnings of our chemical industrials.

IN THIS post-war renaissance American industrials took the opportunity to strike out boldly into entirely new production policies. Existing processes were sometimes known to be obsolete so that it was not a question of duplicating an existing installation. Rather, new methods had to be developed to produce the best possible product at the least cost in raw material and labor. Increased efficiency in processes and improved labor-saving equipment has resulted in greater output per worker, at the same time maintaining American high standards of wages. Engineering decisions based on actual facts took the place of hunches, and guesswork. The old method of yearly and monthly costs was replaced by daily costs, and what is more important, by the actual operating cost of each piece of equipment installed. Extensive experience with replacement and costly repairs during the war period pointed the way to improved design of existing equipment. Other improvements resulted from intensive research into the design and operation of

¶ More progressive American chemical industries are today equipped to meet an intensive world competition because of ten years of constant effort toward improvement in production and distribution methods. Those that have failed to recognize this need for modernization are confronted with problems that threaten their very existence.

SELF PRESERVATION

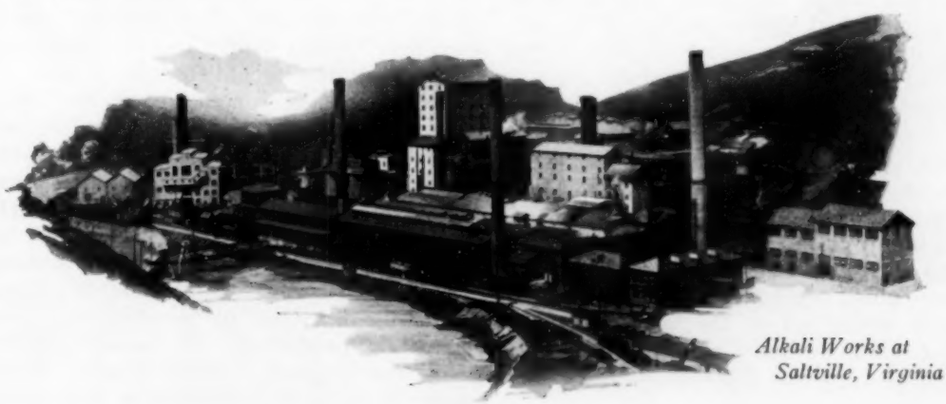
each producing unit, and of the steps that made it a part of the manufacturing process. In short, the engineering method predominated, with management co-operating to make possible the greatest return on the money invested in the modernization program.

IN CONTRAST to the practices followed by the most progressive American manufacturers, the German industrialists apparently overlooked one very important factor, namely, the rapidly increasing cost of German labor that was bound to follow the stabilizing of their currency. During the early period of depreciation, the German industries built large additions to their manufacturing capacity, duplicating existing installations without consideration of the necessity for increased efficiency. During the past twelve months, labor in German chemical industry has increased from 65 pfennig to 90 pfennig per hour, and it is the belief of many the rate will shortly reach one mark (or practically 25 cents per hour). Hence the German chemical industry has a situation which may force it to use present high-priced money to install new and elaborate labor-saving machinery and at the same time scrap much of its present capacity in manually operated processes and equipment.

¶ An eminently successful chemical manufacturer here reviews and carefully appraises the managerial, financial, and engineering elements that have contributed to this modernization of the industry. His summary of past developments and suggestions for future improvement can be read with profit by management in every process industry.

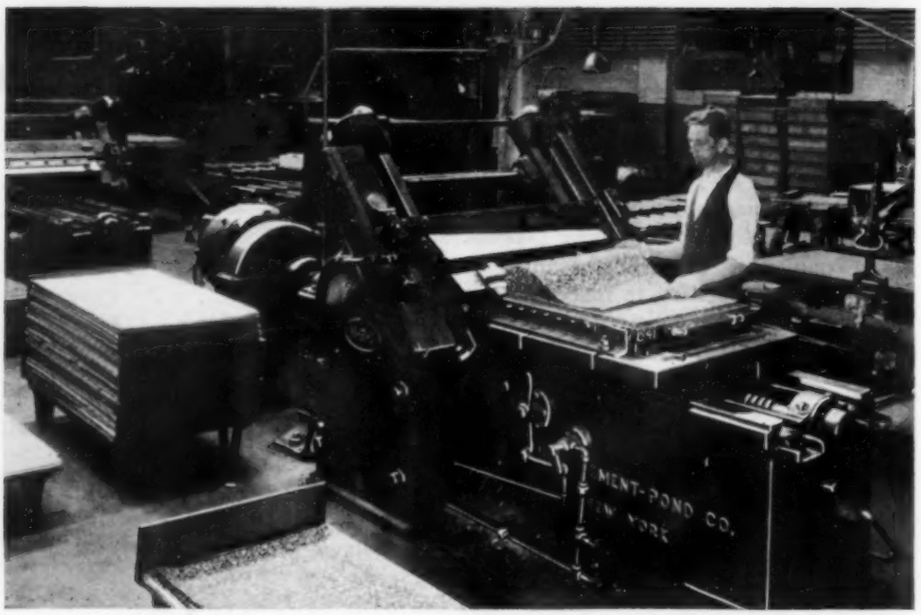
IN MY OPINION those American chemical industries that have taken full advantage of the past ten years to modernize their production and distribution processes are in the same relative position of advantage, as regards foreign competitive practices, as they were before the war. For those companies that have failed to prepare their plants and sales organizations for present and prospective competition, I would sound a note of warning. There have been too many tragic examples of industries that have clung too long to once profitable but now thoroughly antiquated processes. They have fallen behind the march of progress. They have been unwilling to pay the price by investing a portion of their profits in process improvement and modernization.

THERE ARE executives and directors who sit back with a feeling of smug complacency, content with the fact that someone once said that their plant is the "largest" or the "best" or the "most modern" in the industry. They forget that those adjectives were probably applied ten years ago and that every plant that is built in the chemical engineering industries is superior in some way to all existing plants. To management in these industries, I would repeat a warning once sounded by the president of one of our most progressive iron and steel industries, "Beware, lest some more efficient competitor is today building a plant designed to take care of your share of tomorrow's production."



Alkali Works at Saltville, Virginia

"Sheeting" Celluloid



How One Company Carried Out Its MODERNIZATION *Program*

By W. S. Landes
Works Manager, Celluloid Corporation
Newark, N. J.

LUXURIES WE ENJOY in our homes today become the necessities of tomorrow. In industry, what appears to be an extravagant expenditure may be justified by the results demanded a few years hence. The latest marvel of mechanical efficiency will sooner or later be supplanted by something better. This applies alike to organization, methods, equipment, processes. Every plant manager knows that he is expected to produce high-quality goods at lower costs. If the volume of sales is not sufficient to fill the plant to capacity, there is all the more reason why he must look to his labor efficiency, machine output, and process yields for the desired saving. Modernization has become a scientific study. It requires imagination and courage, as well as sound judgment to spend money in order to save money. We see examples on all sides and in every branch of industry.

In the last decade, many concerns, especially those organized fifty or more years ago, have been going through a period of readjustment. The World War brought to a sudden climax conditions which might otherwise have been gradual developments. This was particularly true in manufacturing industries where there was large investment in plant and special equipment.

Older manufacturers in more than one industry, although basically sound, were at a decided disadvantage where this situation had not been thoroughly anticipated. In the buyers' market which followed the war, younger organizations with more favorable locations, modern plant layouts, and improved mechanical equipment were able to step in and make profits, while many of the old line companies were going through periods of pain and poverty to establish themselves on the same basis. It was necessary for some to build entire new plants. Others laid out plans of gradual replacement and modernization.

This was the outlook which faced the Celluloid Company in the fall of 1920.

Organized in 1871, as the result of John Hyatt's invention to produce a substitute for ivory in billiard balls, the company was the pioneer in an industry that has since grown to very large proportions. Now we have the non-inflammable celluloid, made from a cellulose acetate base. The word "Celluloid," originally a trade-name, has long since become a generic term.

In the early days, The Celluloid Company of America, as it was then known, was protected by certain basic patents. Processes and formulas were deep secrets known only to a few trusted individuals. There was no competition. Selling prices were high. As long as The Celluloid Company was able to supply the market, others hesitated to enter a highly specialized field which required skilled workmen and large capital investment.

The rapid expansion of business in the last twenty years, and particularly during the war, however, encouraged competition. Furthermore, many of the celluloid patents had expired. The business was no longer a monopoly. It was natural too that the possible effects of this competition would be underrated. War profits helped further to camouflage the real situation. Then came the upheaval of 1920. Simultaneously with the sudden dropping off of business, and in common with many others, the Celluloid Corporation found itself with a large inventory, an overmanned plant, and a producing capacity in excess of requirements. Some of the mechanical equipment was obsolete and costly to operate. Some of the newer machines, hastily designed and built during the war, had to be reconstructed to permit of economical production. A co-ordinated research program was required. Labor efficiency needed improvement. It is said that competition is the greatest stimulus

to progress. The following is an attempt to describe the major steps in a development program that has been largely responsible for the success of the Celluloid Corporation and is paving the way for further expansion.

The first step involved basic changes in processes. In the manufacture of celluloid, the pyroxylin is mixed with camphor and liquid solvents, kneaded to a dough-like mass and then rolled into slabs. For many years, the accepted practice was to grind the water-wet pyroxylin with the camphor in a special mill. The resultant mixture was pressed into cakes. This operation squeezed out some of the water. The rest was removed by drying the cakes between absorbing pads. Later, vacuum dryers supplanted the pad dryers. The cakes were broken up in a cracking machine, the solvents added and the material allowed to stand at an elevated temperature for two to four days. This process was not only costly but extremely hazardous. Three to four per cent of the material was lost in handling. Alcohol dehydration, made possible by the lowered cost of denatured grain alcohol, replaced the former method. The only new equipment needed was the dehydrating presses, by means of which the water in the pyroxylin is displaced by alcohol. The change necessitated the scrapping of considerable equipment, but the savings in operation in the first year alone offset this by 50 per cent. The operating force was reduced and 5,000 sq.ft. of floor space was liberated for other work. The advantage of dehydrated pyroxylin was carried one step further. It was found that thorough mixing with the camphor took place in the short time the material was in the kneader. Vacuum pumps and condensers were added and the excess solvent recovered. This in turn reduced the rolling time, thereby affecting further substantial savings.

Another important development was in the film-making department. For years the solvents were blown out into the atmosphere. Twelve years ago the margin of profit on film base was such that serious consideration was not given to recovering the solvents. Anticipating the necessity, however, for increased efficiency in the future, experimental work was started which eventually resulted in the installation of a complete solvent recovery plant. Today 75 per cent of the solvents are recovered. The savings have paid for this plant many times over.

NOT many years ago, scrap was almost a drug on the market. Its only value was as a source for the recovery of the camphor. The introduction of synthetic camphor, however, led to lower camphor prices, which made recovery uneconomical. This, together with the necessity for lower production costs in the manufacture of celluloid, led to the re-working of scrap. By careful selection, a product of unusually high quality is obtained. Not only is process scrap utilized, but large quantities are purchased from customers and reworked into suitable material.

Mechanical improvements have brought about changes. Much has been done in the last ten years to standardize equipment. In the nitrating department, the obsolete special equipment was replaced by standard dipper units, such as are used in the manufacture of nitro cellulose for smokeless powder. Acid storage tanks were replaced with a modern system providing for complete settling and filtration. Improved facilities for washing, bleaching and handling the pyroxylin were also installed.

Prior to 1920, the entire output in the converting division was handled on 30-in. rolls. These small rolls were particularly suited to the production of ivory, shell and other variegated materials which were in vogue fifteen and twenty years ago. With the developments in the rubber industry came much larger and improved rolls. A program for gradual replacement of the 30-in. rolls with 60-in. rolls of four times the capacity was adopted. Today over 50 per cent of the production is handled on these jumbo rolls in half the time and with half the former labor cost.

IN MAKING CELLULOID, the next operation after rolling is pressing into large blocks from which the sheets are cut on a planer. Nearly all of the block presses have been supplanted by larger and more efficient ones. The old hand feed planers have been replaced with heavier duty machines. These operate faster and are equipped with automatic feed. The result is more accurate gage. Each planer is operated by one man where two were required in the past.

In the articles department, where finished goods are fabricated from sheets, rods, and tubes, considerable advance has been made in the installation of up-to-date equipment. Formerly, toilet ware and other articles were band sawed from sheet stock. Today they are blanked out on automatic presses. The stock is previously softened by immersion in hot water. Hand routing and beveling of edges is now done on variety machines. Brushes are turned out much more economically by automatic bristling and filling machines. Combs produced in automatic comb-cutting machines have, to some extent, replaced the more expensive sawed combs. With the adoption of celluloid as a material for fountain pens, a cheap and efficient method of surfacing rods and tubes was required. Centerless grinders were tried out and adopted for this operation. It is the policy of the company to keep in touch with other industries, and either adopt standard machines wherever possible, or utilize ideas in the design of new equipment.

Because of the large amount of process steam required in celluloid operations, the company has, for a long time, maintained its own power plant. A few years ago, a complete survey of the power equipment was made. Contrary to the predictions of some, it was found that power could be generated more cheaply than it could be bought. As a result of this survey, however, further improvements were made in the boiler room.

In 1921, when the management began to dig into costs in general, it was found that repairs and maintenance to equipment in the plant were abnormally high. This was due to the insistence of the production department in keeping machines in operation with only make-shift repairs. The greatest stress had been laid on production. Foremen would refuse to release a machine for necessary overhauling. This policy was changed. As a result repair costs over a long period have come down considerably. A systematic inspection of all mechanical equipment was also inaugurated. Today there is complete co-operation between maintenance and production.

The Celluloid Company moved from Albany to Newark in 1873. The original plant was re-built in 1888. Many of the buildings erected then are still standing and being used for production. They have been kept in a good state of repair, and modern heating and ventilation has been installed. By painting the interiors white, the lighting has been vastly improved. The result is a fairly presentable shop even today.

Four new buildings have been erected since 1920. The first one was a new stock room, for storing finished

sheets, rods, and tubes. This building is thoroughly modern in every respect, with fireproof compartments and the latest approved method of storing material. In case of fire in a vault, all doors are automatically closed, a spacious vent opens at the top to prevent the accumulation of excessive gases, and two sets of sprinklers are put in operation. One throws a curtain of water on the side walls, to prevent heating or possible transmission of the fire to the adjoining vaults.

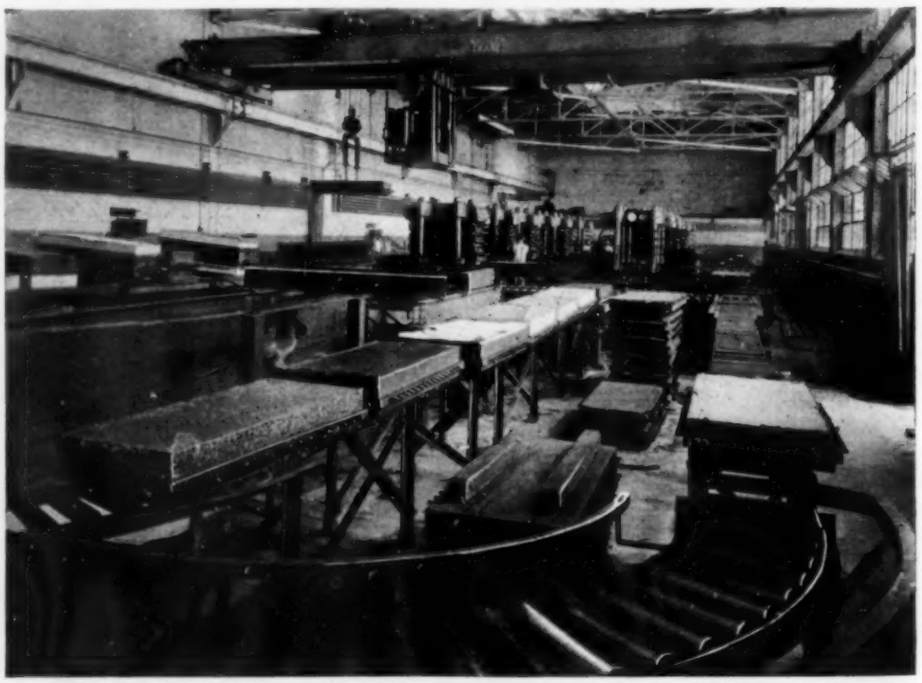
Another new building was provided for all finishing operations. One of the features of this building is filtered washed air to prevent dust from accumulating and being pressed in the surface of sheets. To house the new equipment in the pressing and sheeting operations, a modern, new building was provided, equipped with electric cranes, roller conveyors, monorail, and jib cranes for handling the heavy blocks. A small plant was also recently built for the experimental production of non-inflammable celluloid. This building has been equipped with special fume ducts and unit heaters to handle the ventilation.

Prior to 1923, the fabricating work of the company was done in three separate departments. These were originally independent companies, taken over by the Celluloid Company in 1890. They were all some distance apart in the plant layout. Brushes, combs, and mirrors were made in one department, novelty articles in another department, and special contract jobs in a third. These goods were all transferred to a fourth department, from which final shipment was made. There was always confusion and delay in filling orders. A separate supervisory force had to be maintained for each department. After a careful survey, it was found that, by means of a slight re-arrangement, all four departments could be assembled in a single group of buildings already occupied by one of them. The move was made. Tremendous savings in production cost, but also better quality, and vastly improved service to customers have resulted. The buildings originally occupied by the brush and comb department were eventually sold, when it became apparent that this space would be no longer required.

In 1925 the general office building in New York City was sold, and all offices, except sales headquarters and a show room, transferred to the plant at Newark. This step was a blessing in disguise. It was done primarily to save the heavy expense of the New York headquarters. Other savings incidental to the move loomed even larger. It was found that many records incident to billing, accounting and finished stores, previously duplicated, could now be consolidated. The clerical force was reduced. Much valuable time previously lost was saved.

During and immediately after the war, material was in such demand that customers actually implored the sales department to fill their orders. It was necessary, at that time, to pro-rate the output among various customers. As a result, the company assumed a more or less independent attitude. There was no effort made to schedule orders. Frequently customers waited for months for material that they could not obtain elsewhere. With the falling off in demand, in 1921, customers naturally bought where they could get the best service. To meet this situation, it was necessary to install a complete system for planning and scheduling of orders. This was no small undertaking because of the variety of products. In sheets, rods, and tubes, there are as many as 3,000 active colors, thicknesses, finishes, etc., and almost the same number of styles in fabricated articles. It was a gradual development. Today it has grown into a planning department that supervises all production. Every customer's order, as soon as it is received, is scheduled and an acknowledgment sent out, specifying the exact day the material will be shipped. A complete card record shows the status of all orders, production, and shipments at all times. Each department schedules its own production, in detail. There is a follow-up to see that these production plans are carried out. The shipping department makes up a daily report, listing the orders which they fail to ship on time, together with the reason for the delay. An explanation is required in each case. Such orders are immediately re-scheduled. The average time for filling an order is less than half the old schedule. The inventory of finished goods required to maintain this service has not increased. In fact, by the establishing of order points, which vary from one season of the year to another, it is possible to so plan the production that the average inventory has been lowered. When one makes the comparison with the condition seven or eight years ago, one wonders how any business was obtained. Recognition of this same problem has brought the production and sales departments into much closer harmony.

For many years Celluloid workers were recruited from the section of the city where the plant is located. Quite a Celluloid community sprang up. Most of these men



Blocks of Celluloid Are Formed in Hydraulic Presses Preparatory to Cutting Into Sheets

had worked many years for the company and were quite expert in their particular operations. With the influx of new labor, during the war, and changing labor conditions, efficiency fell off considerably. Operations were, for the most part, on an hourly basis. Where piece work was in effect, the standards had been more or less loosely determined. It was evident that labor efficiency would have to be improved. An investigation was conducted of the various plans available. After careful consideration, the Bedaux Plan was selected. It is largely a matter of personal opinion which of the many incentive plans is the best. However, it is a foregone conclusion that no plan will succeed unless the management is back of it solidly and recognizes the fact that an enormous amount of effort and supervision is required to get the proper start. The company experienced two minor strikes and several other temporary set-backs, but today neither the management nor the workers themselves would listen to any other plan. It has been an unqualified success. The total savings in labor have not only exceeded 25 per cent, but the workers themselves are earning an average of 20 per cent more than previously. The efficiency of many operations has been improved, as a direct result of time studies taken. Through a system of penalties for bad work and extra quality premiums for work above average, the production department has been able to increase the quality of the product and cut down scrap losses. In spite of the fact that the entire plant is now on this incentive plan, it is felt that the work is only half finished. There are many ways in which the system can be utilized to control inventories, indirect materials, accidents, etc. These will be utilized as soon as time permits. The standards department, which is responsible for the setting of all standards and measurement of work performed, has also developed a slight modification of the Bedaux Plan for application to the various offices. This application is now about 75 per cent complete. It has been responsible for the elimination of one out of every three of the clerical workers, with the same beneficial results as were obtained in the factory. Very little work has been done, in general, in the application of incentive plans to office help. In a great many establishments, clerical workers are really less efficient than the average factory worker.

TWO YEARS ago, budget control of operations was set up. The results of the first year were quite gratifying. The preparation of the budget started with the foremen and was assembled on up through the department heads. The final compilation and checking was left to the assistant to the vice-president. The second year, a much more accurate budget was worked out. So far this year, everyone is making determined efforts to see how much below the budget the actual costs can be held. One of the features of the budget is an automatic arrangement, by means of charts, to calculate the variable overhead expense incident to fluctuations in the volume of production. All materials and labor are directly proportional to the output. Standards costs also came in for a thorough review. The standard cost system in effect was brought up to date. A thorough analysis, explaining all variations between actual and standard costs, is made at the end of every month. The department heads check over this analysis with the greatest of interest.

The management has come to realize that research is a very definite and necessary part of the company's activities. This division, organized several years ago, is known as the development and research department. One section of the department is concerned with pure research. Another section is responsible for development work, periodical review of formulas, and quality of the product. A further valuable service rendered by the development and research department is the systematic reviewing of patents granted, as well as the taking out of patents on processes and inventions of our own employees. To provide better facilities, a complete new testing laboratory was installed with the best equipment obtainable. The physical laboratory has also been provided with modern instruments.

Some of the accomplishments of the research department have been several new formulas, which are saving many thousands of dollars a year; a modern electroplating technique, which has lowered expenditures for this work as well as the reduction of spoiled work to a minimum; and the development of several new products.

EXPERIMENTAL work by the research department in developing celluloid for use in laminated glass has contributed greatly to the recent rapid strides made by automobile manufacturers in the adoption of this product.

Besides many new color effects in ordinary celluloid, the laboratory is also working on a non-inflammable molding powder and other products of a different nature.

The latest efforts have resulted in the development of non-inflammable celluloid, made from a cellulose acetate base. The research department had been working on this for some time prior to September, 1927. At that time a merger between the Celluloid Company and the Celanese Corporation of America was announced. This merger not only broadened the scope of the company's work considerably, but brought together the facilities and technique for producing high quality cellulose acetate and a skilled organization for converting it into plastics.

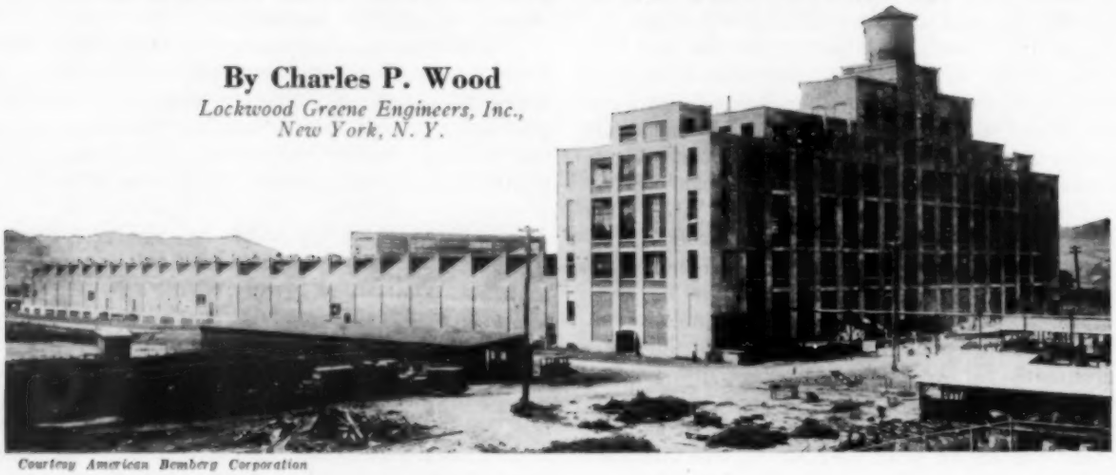
The labor incentive plan has "made" many of the foremen. In fact a man has to produce or step aside. A mediocre man cannot stand the pace. The department heads and other executives are also more efficient. Their number has been reduced. In two years, during which time the volume of business increased slightly, the executive payroll was reduced considerably. Now there is practically no overlapping of authority. Every man has enough responsibility to keep him busy all the time. This year an executive incentive plan was inaugurated. This bids fair to stimulate further accomplishment. The performance of the group as a whole is measured according to pre-determined standards in cost reduction, quality and service to customers. The points earned are translated into a percentage of each man's salary. The group meets once a month at dinner to discuss plant problems.

The outlook for the future ten years hence is promising. Much has been accomplished by carrying out a systematic program of plant modernization. The savings effected have been instrumental in maintaining the ever-threatened margin between costs and selling prices. There is still room for improvement. Ideas that are already being discussed may revolutionize the whole process of making celluloid. No one would venture to predict just what equipment will still be in operation ten years from now. Certainly, some of it will be consigned to the scrap pile. Needless to say, the chemical engineer will play an important part in the development of the improvements that lie in the offing.

Modern Practice in

LOCATION LAYOUT *and* DESIGN

By Charles P. Wood
Lockwood Greene Engineers, Inc., New York, N. Y.



Courtesy American Bemberg Corporation

IS OUR PLANT in the wrong place? Is it obsolete? What would we do if we could start all over again? What proportion of our manufacturing expense is made up of: Wages? Power? Freight and transportation? Repairs, maintenance and fixed charges on buildings and equipment?

What savings could be made by: A better layout? A better building? A better location?

These questions have to be answered by every manufacturer at one time or another. Something new develops just in time to change the best-laid plans and there is always reason enough to test theories that apply to the vital features of a business.

Time spent on a study of business prospects and improvements to equipment and operating methods will be more profitable than time spent trying to correct something after it has gone wrong.

Only a few of the complex requirements of many different manufacturing enterprises can be mentioned. There are some features that are common to many plants and there are fundamental requirements which may be stated for the layout, the building and the location. Some of these will be discussed with the object of arousing more interest in looking ahead and getting ready for everything that can be foreseen.

The location of new manufacturing plants at the present time is a problem quite different from what it was a few years ago, when the demand for products exceeded the capacity of existing plants.

Today, even with the country prosperous and business good, there is manufacturing capacity sufficient for overproduction in every important branch of industry. It has been estimated that American manufacturers, on the average, will have to export fifteen per cent or more of their products in order to maintain their present wage scales and number of employees.

With surplus producing capacity during a prosperous period, what are the prospects for manufacturing plants during a business depression which may be expected every now and then in the future, as in the past? It is clear that part of the present equipment will be left idle and that some of the workers will be laid off until business picks up again. This means that some entire plants will shut down.

In spite of the present state of overproduction, there are opportunities for new manufacturing plants. These opportunities may be divided into several main classes:

A. Plants to make new products.
B. Replacement of obsolete or worn-out plants.
C. Movement or replacement of plants which originally were at the wrong location.
D. Movement of plants or new branch plants to take advantage of new markets or new transportation facilities, and to meet changed conditions.

Before discussing other factors that influence plant location, it must be said that money is always needed. The place that can raise money for industries has a great advantage over places where money is hard to get.

ON THE BASIS of manufacturing efficiency, the factors that influence the location of the four classes of plants already described will be taken up in order.

Class A may be any kind of plant to make something new. A local inventor or a local capitalist may keep the industry where it started. If the manufacturing process requires something that is not available locally at competitive costs, then the new industry will have to start where conditions are right. In such cases, the main requirements will probably be one or more of the following:

(1) A good local market or economical transportation to a good market.
(2) A supply of raw material at reasonable cost.
(3) A supply of suitable labor at reasonable wages.
(4) A supply of power or fuel at reasonable cost.
(5) Freedom from adverse legislation or unfavorable outside influences.

One or more of these five fundamental requirements will apply in nearly every case. There are many other influences which are much less important one at a time but which combine into groups that may outweigh the more important single factors. Such things as climate, health, recreation and housing are reflected in the quality and cost of labor. Where the managers and superintendents want to live is an indefinite but a real consideration. Taxes, insurance and other incidental expenses become controlling factors when there is a choice among several places that share the same principal advantages. Water supply is part of raw material in some processes. Freight rates, usually, are the measure of transportation facilities. The cost of land and buildings should not vary enough to offset decided manufacturing advantages but in some cases it does. It may be assumed generally that factory wages will be high in the same place where wages are high in the building trades and so the decision would be based on labor costs instead of building costs.

Class B includes plants built to replace obsolete or worn-out plants without changing the location. New discoveries or improved machines, that revolutionize processes or compel the rearrangement of buildings and equipment, account for many of the new plants in this class.

Class C includes only the plants that were always at the wrong place. The movement of these plants is forced by competition from other plants properly located. Such plants have failed more often than they have moved because they lost their credit, as a rule, before they found out what the trouble was. In this respect, the present widespread interest in securing new industries is fortunate for the old plant at the wrong location. There is no longer any reason why the manufacturer should not be aware of the advantages offered by many progressive communities throughout the country. If he does not know all about his own business, they will try to tell him.

Class D is the largest and most active group of industries that seek new locations.

MANY NEW PLANTS start as distributing branches, where stocks are carried in warehouses. If the amount of business done by a branch reaches a certain point, with prospects of increasing, and if the branch is in a section where conditions are favorable to manufacturing, the company can afford to start a factory to make the goods formerly stored in the warehouse. Good roads have contributed largely to the efficiency of branch warehouses because motor transportation has improved the local distribution service and increased the volume of branch business.

The West and South particularly have profited by this development and more industrial activity is foreseen for these sections as more new roads are built and as the population increases. The trend of population is towards the Southwest, as it should be, because there is where the most valuable undeveloped resources and the most room for growth are to be found.

Another reason why established industries sometimes build branch plants instead of enlarging the main plant is the policy of distributing the investment. The company may feel that its risk will be less if its future is not dependent altogether on conditions in one locality. It may foresee labor trouble, adverse legislation, high taxes or something else that prompts the management to start operations at some more favorable place and to divert production from the old to the new plant whenever it becomes profitable to do so.

A SOURCE OF NEW INDUSTRIES is the tariff on foreign goods. European manufacturers in some lines have found that they can increase sales and save money by building branches in America. Manufacturers of textiles, chemicals, toilet articles, and luxuries, have been leaders in this movement. The great buying power of America in its present prosperity and the contemporary depression abroad make the American market more than ever attractive to foreign manufacturers.

This sketch of industrial opportunities and the factors that influence the location of manufacturing plants is based on national rather than on local conditions. The most important influences have been shown, so that the prospects of any particular place, whose resources are known, can be estimated by finding out which of these influences is the strongest.

Several fundamental requirements have to be satisfied before the details of the plant arrangement can be completed.

The relation of the receiving to the storage and shipping departments is studied to provide for the assembly of various materials and routing through the process with a minimum amount of handling and the shortest travel that is practicable.

The plant is required to maintain a certain production. A neck-of-the-bottle will appear somewhere in the course of the lay-out. The tendency to depend on a complicated or delicate mechanism to preserve the original scheme has caused trouble in many cases where the arrangement looked well on paper.

The size or shape of the lot may affect the layout. Land may be so expensive that a multi-story building has to be built where a one-story building would be ideal. For the purpose of this paper, it will be assumed that the plant site does not affect the size or shape of the building. Then, the character of raw materials and the product and the requirements for communication between departments will determine, first, whether the routing will be vertical or horizontal.

Vertical routing suggests itself for a process where the materials are readily unloaded and conveyed to storage at the highest point by mechanical means and where the process can be arranged to start on the top floor and progress by gravity, through succeeding stages, to the final operation on the first floor which ends with packing and shipping. This scheme has to be modified where time is lost by too many workers going up and down stairs or where costly elevator service is needed.

HORIZONTAL routing is best for operations such as machine work, furniture and textile manufacturing, where uniform lighting and accessibility are very important. A rectangular one-story building with north light through a sawtooth roof seems to combine more advantages for general purposes than any other type of building can offer.

Provision for future extensions and increased capacity must be considered to get a good layout. Possible future changes to the process, also, affect the scheme. Otherwise, expensive alterations may become necessary later, although the layout was good with the original equipment and capacity. Some of the most efficient

plants are laid out in units that can be expanded without interference with the first arrangement.

The correct layout will insure a minimum expenditure for labor, power, machinery maintenance and building maintenance. It will also protect the owner against an excessive building investment that would run up the fixed charges on the plant.

Labor and power economies result from such things as proper routing of materials, substituting power for hand work in the proper places, taking advantage of gravity movement and precautions against power transmission losses.

The layout can reduce the cost of building maintenance and machinery maintenance by locating machines where they can be supported properly and where they will not be subject to useless exposure.

The ideal layout may have to be modified to get a good building at a reasonable cost. The building, however, should be considered only as something built around the productive equipment. Many trial arrangements and estimates have to be made, as a rule, before the best combination of building and layout can be found.

Courtesy American Bemberg Corporation

View of a Spinning Room in a Rayon Plant
The most convenient arrangement and the greatest possible saving of floor space is accomplished by wide column spacing.

MANUFACTURING is so competitive that success generally depends on producing a large volume at a low per cent of profit, so the building must be classified as productive equipment, credited with protection given to machinery, workers and stock, and charged with interest, depreciation, taxes, and maintenance, as well as other "overhead" items.

The lowest first cost consistent with good materials, workmanship and utility is the rule for manufacturing buildings. There are exceptions where zoning regulations or advertising value either require or justify additional expense for better appearance. Good material and good proportions affect the cost only slightly and improve the appearance more than mere ornamentation. The choice of materials is affected by climate, local prices, local wages in building trades and labor troubles as well as by what is required for strength and durability. The requirements of chemical plants are often more exacting than for other plants because the materials used in the process may damage the structure. Familiar examples are: a textile dye-house, where acid fumes will destroy exposed steel; the washing department of a rayon plant, where acid-proof floors are provided to catch the drip which would damage ordinary concrete, or usual floor construction.

Some of the troubles that develop in the building structure start from the simplest causes. A wood floor laid near the ground without provision for air circulation underneath may rot within a short time. Laid on an ordinary concrete slab resting on the ground, a wood floor will rot; cinders and asphalt waterproofing should be laid between the concrete and the wood. Condensation from the ceiling will drip and damage the product if the roof is not insulated. Many other cases could be cited. The point is that time and money can be saved by looking ahead and providing against these things when the plans are being made rather than by make-shifts after the trouble has started.

The machinery lay-out determines the best column spacing. When the distance between columns approaches 25 ft. there must be a decision as to how much the longer spans are worth, because the cost of the building increases as the column spacing becomes greater. On the top floor, or in one-story structures, wide spacing may be accomplished by trusses set in vertical sawtooth skylights. With the sawtooth roof, portal construction will dispense with the horizontal members between columns to give more head-room and a cleaner, better appearance.

VIBRATING LOADS are a troublesome problem. To change the layout so the heaviest vibrating loads will rest on the ground may be a very extravagant arrangement. The cost of operation has to be compared both ways with the cost of building. Buildings carrying heavy rubber mills and printing presses on upper floors without appreciable vibration have demonstrated that designers can solve vibration problems.

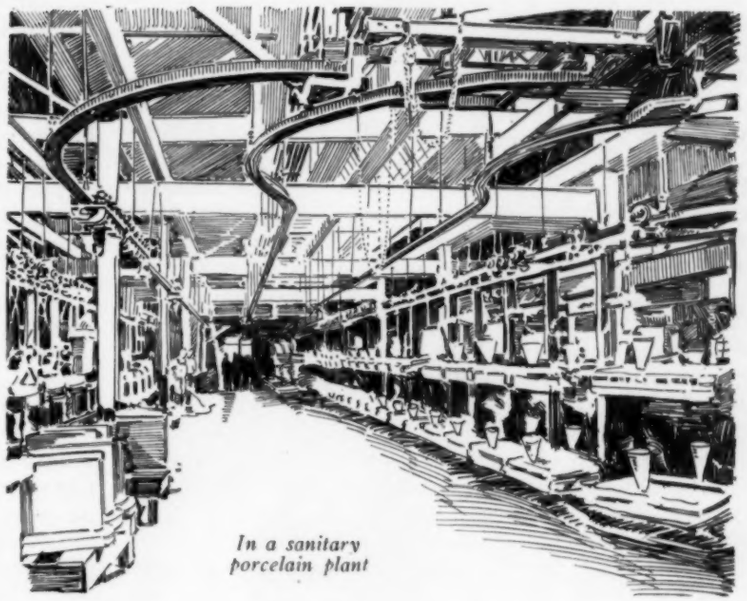
Complete building plans and specifications, with assurance that competitors are on the same basis, demand the lowest price from a good contractor. Trading on the obscure requirements of incomplete plans generally causes the owner to lose either through high cost or through poor quality of work. The contractor should make a profit if required to do good work. He can do so without extra cost to the owner, if he knows from the beginning what has to be furnished. The contractor always has the advantage when charging for changes or additions made necessary by faulty design.

Simplicity is the end in view, even though some of the foregoing may seem to indicate that industrial buildings are complicated. A building that will be adaptable for changes in the process or convertible for other purposes is a better investment than one that suits only the original occupant. How to have these desirable features without wasting space or increasing running expenses is a problem for the engineers engaged in the work of designing buildings for the precess industries.

MATERIAL HANDLING

... A Factor in MODERNIZATION

By G. L. Montgomery
Associate Editor, Power



In a sanitary porcelain plant

MACHINE INDUSTRIES and process industries have, in the main, developed along different lines. In the general manufacturing field the controlling factor has been the reduction of labor costs, primarily by the substitution of mechanical power for human effort. In the chemical engineering field, the governing factor has been the necessity of accurately and completely carrying out some technical process, some change in the nature of the raw materials used.

Machine shops, for instance, are now laid out and operated so that the labor involved in changing the raw materials to their new form or arrangement as finished products is the minimum obtainable. Handling the materials between machines or operations has been one of the chief points where labor saving could be effected. This has resulted in a concentrated study of the subject of handling, from which have grown the systems of mechanical material handling which are the basis of mass production methods. Human labor has been practically eliminated in these machine industries and the handling system has become the most important factor in governing the plant layout and the conduct of manufacturing operations.

In contrast to this, the basic consideration in the process industries is, and must remain, the accurate completion of some chemical change in the raw materials. All other things must be considered after this necessity has been fulfilled. Because of this requirement, material handling methods have heretofore had but little influence on layout and operating methods in the process field.

Managements have been thoroughly aware of these facts. Though they have looked with something of envy at the great economies realized by the machine industries, the difficulties surrounding a like course in the chemical engineering group have seemed to many to be insurmountable.

Therefore the tendency has been to stick to traditional methods. These methods are safe. The production per unit of labor may not have increased in an amount comparable to the results achieved in other fields, but the product continues to satisfy the specifications.

Of course, in industries where the materials are in liquid state throughout the process, as in petroleum refining, relatively economical handling has been obtained since efficient pumps were first available. Also, in the hillside type of plant, as found in tar distilling or smelting, gravity flow has eliminated all handling labor.

But, where materials are solid and gravity cannot be used to move them, mechanical handling equipment has been until recently only an incidental aid, not the governing factor in the industry. It has had but little influence in modernizing these process industries.

Recent experience has proved, however, that mechanical handling systems can make savings for the chemical engineering field comparable to those in any other line of endeavor. The adoption of these systems has not only resulted in saving labor for handling, but has necessitated the modernization of all the other equipment. Where this has occurred, there has been a marked increase in plant output and substantial production cost reduction.

Some of the earliest examples of this are found in the ceramic industry. Perhaps no industry has, in the past, been more hide-bound by tradition or has had less interest in engineering methods outside its own bounds. But ten years or so ago, the pressure of war conditions and changes in personnel brought about a new attitude in this field. Handling equipment was adopted to the fullest extent by certain plants. It was found that this move called for new arrangements of equipment, new designs in equipment, in certain cases, and new operating methods. But the result was lowered cost of production, less spoilage, and better, almost automatic, control of quality.

A plant manufacturing insulators was an early example of this. It was equipped with a complete mechanical handling installation. No new production equipment was bought, but the old equipment and the sequence of departments were rearranged to permit continuous, straightline flow. The time for loading and unloading a kiln was reduced by two-thirds. The number of employees was reduced by 40 per cent. Rejected or unsatisfactory finished goods were held below 10 per cent, less

than half of the former figure. And output was doubled without increasing the size of the plant.

In the face of a storm of criticism and even ridicule from others in their field and from their own employees, the management of this plant drove ahead to success. They proved that the modernization attendant on the adoption of mechanical handling equipment could be as profitable in the process field as in other industries.

About the same time a naval officer, in wartime charge of a firebrick plant, made a similar improvement. While it is not possible to give figures as to the savings he made, it is known that they were of real aid in the war effort of the United States.

IMPROVED EQUIPMENT goes with improved handling in most industries. The ceramic field was no exception. The realization of the economic possibilities of the tunnel kiln, itself essentially a piece of material handling equipment, was only brought about by the adoption of mechanical handling methods. A common brick plant that was one of the first to adopt the tunnel kiln soon after installed handling equipment to serve it. Almost immediately it became apparent that the production equipment would need to be modernized in order to match the pace of the kiln and the conveyor. This was done, at considerable expense. But the expense was justified, for the new layout gave a production cost per thousand brick of about one-half what the old plant had given.

Another early example of what mechanical handling equipment could do was the result of a revolutionary forward step by a maker of sanitary porcelain. A new plant was built by this concern, based entirely on the operating needs of the tunnel kilns and fully equipped with mechanical handling equipment. This plant has straight-line, continuous flow from raw material to shipping platform. The labor per unit of production is about one-third that in the company's former plant. Production time has been reduced from weeks to days, giving a saving in overhead and a better competitive position and, most important of all, the quality of the product has been so improved that spoilage is practically negligible.

A few forward steps such as these made it immediately evident that more had been accomplished than the modernization of equipment and operating methods, and the reduction of production costs, important as these improvements were. The control of the changes incident to the processes of the industry had been improved for these had been out of the realm of human error and made a part of, or resultant to, the functioning of a machine and hence susceptible to close control. The improved quality of the output and the avoidance of spoilage quickly repaid the pioneers the cost of their innovations.

OTHER INDUSTRIES experienced this modernization as early or earlier than ceramics, particularly industries using but a few simple raw materials. Cement, lime and gypsum plants completed the advance made by rotary kilns, themselves essentially conveyors, with new processing and handling equipment. Bakeries which adopted the traveling oven soon began to serve both its inlet and outlet mechanically. Acid phosphate manufacture became fully mechanized.

Thus a number of the process industries have adopted, at least as far as their more progressive and profitable plants are concerned, mechanical handling systems, and have consequently become fully modernized in other respects. Sometimes this has been brought about by the use of some piece of improved processing equipment, as in the case of the tunnel kiln, which has set a pace that practically forced the elimination of manual handling. In some cases, as in byproduct coking, industries have been quite fully equipped with handling devices since their first appearance in this country. In still others, the improvement has come from a realization on the part of the managers and engineers concerned of the advantages and economies flowing from mechanical handling and a consequent deliberate adoption of this equipment and the plant set-up that accompanies it.

Until recently, however, two great groups of the chemical engineering industries have not been considered as available for the use of fully mechanized handling systems. On one of these the necessity for absolute accuracy of formula was supposed to make dependence upon human inspection and manual operation inescapable. An example of this class is the manufacture of drugs.

The other group is that where the complication of products or the large number made, each in relatively small quantities, fostered the opinion that no improvement in production methods or lowering of costs could be made by employing a unified handling system. The production of mechanical rubber goods is an example of this second group.

HOWEVER, the new manufacturing system of Eli Lilly and Company, described in *Chem. & Met.*, February, 1928, has proved that these two classes, even when combined in one plant, can benefit from mechanical handling and attendant operating methods as greatly as the automotive industry. In fact, this concern can be regarded as the "Ford" of the chemical engineering field. Ford methods and Ford philosophy of manufacture formed the basis of this development and have, in some measure, been surpassed by it.

The Lilly Company makes more than 2,800 different products, some of which must be produced under conditions that guarantee accuracy of formula. This extremely complicated manufacturing problem has been solved in such a way that one conveying system, automatically controlled, with the co-operation of an efficient planning plant department, permits straight-line, unconfused production of all this varied output.

The same company, at another plant, has applied the same methods to the production of vaccines and serums. This is proof that the first successful application was not due to special circumstances, but rather came from the eminent suitability of the manufacturing methods growing out of the use of modern material handling equipment to the needs of the process field.

To sum up: Management can expect certain definite advantages to follow the installation of complete mechanical handling systems. Labor will be reduced. Production will be speeded up. Overhead will be lowered. Modern planning and wage systems can be readily and profitably adopted. Modern production equipment can be made to give a return that quickly repays its cost. Inspection and control of product is made more dependable. Breakage and spoilage are greatly reduced. And, finally, the conveying system acts as a pace-maker for the factory and so tones up its entire operation.

In view of these advantages, which have been realized by certain plants that have been foresighted, no management should fail to consider adopting a modernization policy that includes the fullest possible use of mechanical handling equipment.

Modern POWER DRIVE *Increases Dividends*

By William Staniar
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RECENT DEVELOPMENTS have forced the recognition that belting and transmission machinery are no longer necessary evils to be selected at random, and installed and operated by antiquated methods, but are essential and important parts of plant operation, requiring and deserving as much care and attention as any other part of the mechanical equipment. Therefore, it is fitting that belting and the mechanical transmission of power conditions as they exist today in hundreds of plants should be brought to the attention of the managing executives of industry.

As an illustration of the importance of power belting consider a $5,000.00 investment in the form of a belt-driven mill such as shown on this page. As a producer and dividend payer it is worthless without its driving belt, which is worth approximately $40.00. Therefore, the dividends on the $5,000.00 investment are controlled by the $40.00 item. This machine is a dependant and by itself cannot produce. Hence its earning power is controlled by the belt, selection of which should receive serious thought, not based on a comparison with their relative values, but on their relative worth, because the belt is the governing factor.

The apparent lack of interest on the part of executives in this important matter is due to their failure to realize its vital importance and the possible losses involved. It is the desire of the writer in this article to create a picture in the minds of these men as to what may be going on in their plants, and what may be done to stop the continuation of the waste.

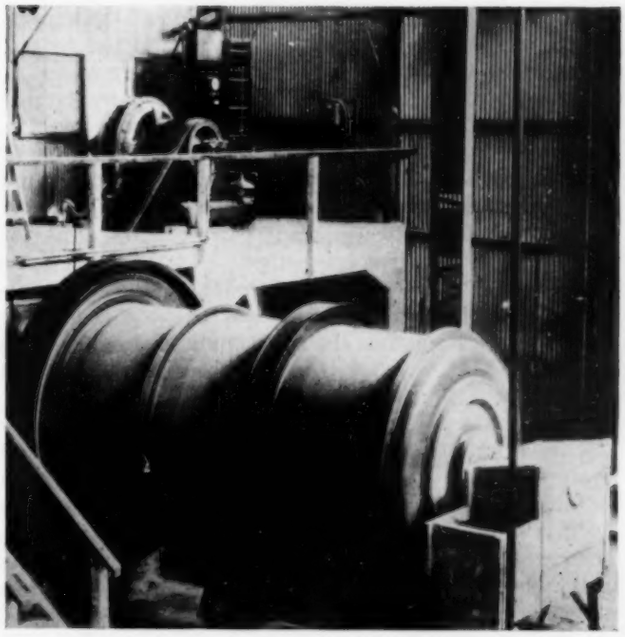
Notwithstanding the fact that all manufacturers and industrial corporations aim to give service and place on the market products of merit and quality, their fundamental business is to pay dividends.

These dividends are generally estimated and based on sales, but do profits entirely depend on sales? Selling prices are very often fixed by competition, therefore savings which are profits must be found to some extent in the purchasing and manufacturing ends by buying with knowledge the commodities needed and installing and operating them intelligently.

The wasteful installation is not necessarily the complicated one. Frequently the simplest apparatus to drive will cost the most, because no thought has been given as to the most economical driving method possible.

The power chain from the mechanical generation to the mechanical application is composed of three links —steam, electric and mechanical. The last link is generally the weakest in the average manufacturing plant today.

The importance of this final link in the power chain is now being realized because research work has demonstrated that it can be made just as efficient as the other two, if proper attention is given to its design and proper supervision to its installation and operation.



Power Belting Usually Controls Disproportionately Expensive and Vital Producing Units

Transmission belting is one of the most necessary of plant essentials. When right, the machinery is producing to capacity; when wrong, there is a puzzling leak of production and, with its failure, both capacity and production suffer. Is there anything, therefore, in plant capacity and operation that ranks higher in importance?

EXECUTIVES OCCASIONALLY inspect the operations and equipment of the plant and generally find a maze of belting and transmission machinery. Owing to the fact that "it seems to be working all right" they are loath to call for an investigation. When a critical situation arises and plant production suffers a set-back due to belting slippage and premature failure, they wonder why this link has failed and all others are intact. During the breakdown, overhead goes on and time and money wastes result.

The actual breakdown is the effect and not the cause of the trouble. The cause is the failure of the plant management to realize that today science should rule power transmission and that they can no longer afford to let price control the type of power belting and workmen control the size for the installation. They should enlist the aid of exact scientific methods if they desire to keep things moving, because all profits and progress in industry come through the medium of motion.

If the mechanical power conditions at most manufacturing plants were analyzed it would not be difficult to

comprehend why the selection, installation and care of belting is generally left to the inexperienced. The writer has interviewed many managers and superintendents on this subject. Most of them realize the importance of their belting equipment and its relation to production efficiency, but their question is—"What can we do about it? We have no one in our organization who really knows enough about belting to make a correct and economical selection." Therefore it is and always has been left to workmen and millwrights. These men know their own line of work but do not and are not supposed to know the particular characteristics and use of the various brands and makes of belting so necessary for correct and efficient application. Some executives are aware of the chaotic condition of their mechanical power transmitting equipment and would welcome a system of belting control and standardization, but being cognizant of the lack of talent in their own organization and not knowing where to look for assistance, they generally turn to technical books or trade papers in the hopes of finding some practicable method. Instead of being helped, they find themselves face to face with mathematical problems and discussions, possibly dealing in calculus, which smother the real commercial engineering of the subject by more plausible theories that do not coincide with practice.

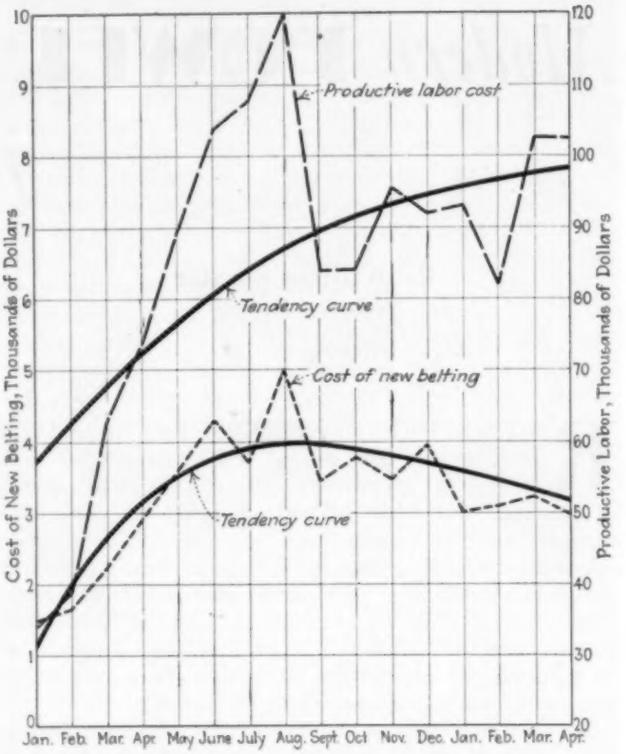
For a number of years tradepapers and technical journals have published article after article on belting and its application. Because of the highly technical nature of the substance, they have been of little help in solving the every-day belting problems of manufacturing plants. Theory and algebraic expressions are excellent in their place, but when it comes to selecting the proper type of belt for the drive, it is experience that counts and not mathematics.

A SYSTEM OF STANDARDIZATION is essential in every manufacturing plant where belting is the medium of transmitting power. Where there is no system of standardization and control, belting costs generally follow production labor costs. Investigations in a number of plants have proven that when there is a control the lowering effect on these costs in relation to productive labor is obvious almost immediately.

The chart illustrates the actual effect of the schedule system of standardization on belting costs in relation to production labor costs in a large plant recently surveyed. It will be noted that from January to August production labor increased from $30,000 to over $120,000. The belting increased in proportion from $1,000 to $5,000, this being before the control system went into effect. During the latter part of August the belting schedules were placed throughout the plant. By October the tendency of belting costs was downward while the tendency of labor costs continued upwards. By the following February and March there appeared a marked effect. Belting costs had dropped to $3,000 with production labor at $105,000. This illustration shows the value of belting control and its almost immediate effect on plant costs and proves that the most dependable protection against the invisible losses of power transmission is belting standardization.

Industrial development and competition are making it mandatory that the methods employed for the mechanical transmission of power be given serious consideration, otherwise "Friction," that unseen enemy of production, will demand its share of the applied energy.

Developments of recent years have brought methods


Productive labor cost
Tendency curve
Cost of new belting
Tendency curve
Cost of New Belting, Thousands of Dollars
Productive Labor, Thousands of Dollars
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct Nov. Dec. Jan. Feb. Mar. Apr.

Cost Relations as Influenced by Schedule System

and systems for the economical distribution of mechanical power that were never heard of in the past and no doubt electrical research and the perfecting of the electric motor are responsible for the divorce of industry from the old power-consuming methods of transmission. Mechanical inventive genius has kept pace with electrical development, because it was realized that the high-speed energy of the motor could not be applied to the general run of machinery without suitable and economical reduction methods. Many systems have been devised for accomplishing this. This necessary development has reached such a state of perfection that all complicated problems of mechanical transmission can be solved by the use of some one of the modern methods.

Direct motor connection versus shafting and belting installations has been a subject of national debate and discussion for a number of years. However, it is not the purpose of the writer to take sides with either method because experience has proven to him that each system has its advantages and each its place.

There are many instances, however, where the use of the shafting and belting system is indicative of low efficiency. Resort must be made to other methods, such as direct flexible coupled motor connection, worm and spur gear reduction units, roller or silent chain connections, modern idler systems or direct exposed gear reductions. Each of these methods or systems serves a definite field and should be considered during the design of new work and as improvements on existing operating installations.

TRANSMISSION OF POWER through line shafting under favorable conditions is more efficient theoretically than is generally supposed. In Prof. Goodman's text, "Mechanics Applied to Engineering," it is shown that if properly aligned solid steel shafting, well bearinged, will transmit power a distance of 6,000 feet with an efficiency of 80 per cent when all forces are

purely torsional. While this is true, it cannot be applied economically in modern high-pressure production plants. Owing to the fact that the average process requires intermittent operations and speeds, high friction loads and low power factors quickly make their appearance. Modern practice has shown that power distribution must be split up. It also has shown that no specific rule can be laid down as to just what method to use; this must be governed by existing plant and operating conditions.

From an electrical standpoint the unit or group shafting and belting system driving a battery of machines requires less power than a direct motor connected battery of similar machines. The starting load on each machine is higher than the running load, therefore, each machine individually motor equipped, requires a motor equivalent to its starting load. The group system can be motorized equivalent in power to a multiple of the machine running loads plus a slight margin, because each machine can be thrown in separately. It is known that the efficiency of a motor is highest when it is operating at or near its rated capacity. When selecting the size of motor to drive a certain group of machines care should be exercised that machines requiring a large amount of power and infrequently operated should not be placed in group with machines requiring light or medium power. Machines of this class should be individually motor driven, otherwise the motor required for the group will be large and operated at part load when these machines of the group are not being used. Peak loads of group machine installations are to a great extent absorbed by the fly-wheel effect of the shafting and pulleys of the system.

FRICTION LOAD in reality is bearing load. It must be considered because it is always present. High- or slow-speed shafting or in fact any rotating part must have bearings and these mediums of support on transmission lines cause friction losses, ranging from 10 to 15 per cent in most all plants of the country.

The following table demonstrates the possible monetary losses involved due to excessive friction loads caused by the use of wrong type bearings. It is based on 4 pounds of coal per horsepower-hour, 300 working days per year, 10 running hours per day and a coal cost of $4.00 per ton:

	POWER LOSS—PER CENT				
Hp. of Plant	10 Per Cent	20 Per Cent	30 Per Cent	40 Per Cent	50 Per Cent
50	$120	$240	$360	$480	$600
100	240	480	720	960	1,200
200	480	960	1,440	1,920	2,400
300	720	1,440	2,160	2,880	3,600
400	960	1,920	2,880	3,840	4,800
500	1,200	2,400	3,600	4,800	6,000
1,000	2,400	4,800	7,200	9,600	12,000

Example of Application of Table

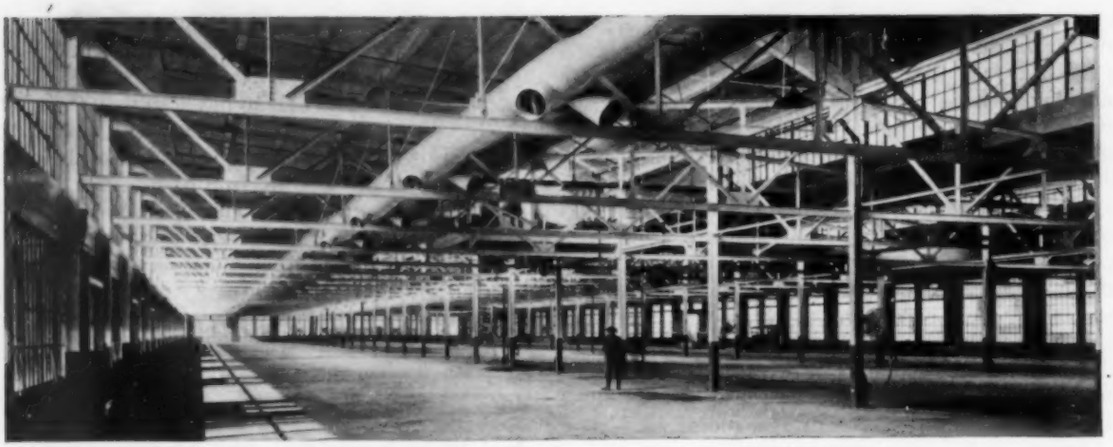
Total bearing friction in a 300-horsepower plant was reduced from 40 to 20 per cent by improving bearings and belting. Required, the annual saving, $2,880 — $1,440 = $1,440.

It is evident from these figures that high bearing friction is expensive. The merits of the various types on the market should be examined before a final selection is made. Lubrication of any type is of paramount importance and an absolute necessity, because the successful operation of any bearing depends upon the maintenance of an oil film between the sliding or revolving surfaces. There are many types of adjustable and rigid babbitted bearings on the market. The real merit of one over another depends on their lubrication methods and facilities. Correct lubrication does more than reduce metallic friction. It reduces power losses by enabling the journals to move smoothly and efficiently.

That bearings have kept pace with the improvement and advancement of mechanical power transmission is evidenced by the introduction of the roller and ball type for line shaft purposes. There can be no question as to the superiority of rolling over sliding contact, or point over line contact. The application of these types should be considered where shafting frictional loads are high and economy of power is a ruling factor. Production delays caused by the rebabbitting of plain bearings due to poor lubrication are eliminated. In some cases as much as 35 to 40 per cent friction load has been saved.

ELECTRICAL and mechanical developments have forced adoption of high-speed prime movers. The slow-speed medium is surely passing into the discard because compactness is economy and today economy is paramount. The high-speed electric motor and steam turbine are more efficient from every angle than the low-speed engine. Consider space alone: a steam engine of five hundred horsepower or more required considerable floor area with a special attendant. The same capacity motor or turbine can be installed in one-tenth of the space and practically left to itself. These compact high-speed units are more efficient, just as powerful and the initial cost is lower than the low-speed power unit. However, all radical departures develop problems; therefore, the introduction of high-speed prime movers for industrial operations created havoc with existing methods of speed transference. It was a simple matter to increase from 150 or 200 r.p.m. to 300 or 400 r.p.m. by belt from an engine, but far different when prime speeds of 3,600, 1,800 or 1,200 r.p.m. were to be reduced to line shaft speeds. It was obvious that this was not the function of a belt. Mechanical genius of necessity has developed and made practicable methods for bringing high speeds within the range of practical application. Compact efficient devices or methods have been devised which permit the use of high-speed units in connection with line, counter or special apparatus. Belting and pulley transmission is most efficient in its place, but, in many instances, lack of room necessitates other methods of reduction. Speed ratios, flexibility and space to a great extent control the practicability of the general run of belt drives. A ratio of 6 to 1 for belting installations is about the maximum for efficient operation owing to the reduced contact on the smaller pulley if higher ratios are used. The modern idler system overcomes this difficulty to a degree but for short center work there are methods that eliminate this fault.

DEVICES AND METHODS for the mechanical transference of power are numerous; thousands upon thousands of dollars have been invested to give the manufacturing world economical and efficient mechanical systems for bridging the gap between power source and application. Regardless of this, however, there are managers of industry who are not availing themselves of modern methods; with the result that the mechanical link between power and production continues on year after year as an unknown waster of money and a brake on production efficiency. Power is an invisible force, whether electrical, steam or mechanical and today the mechanical can be made as efficient as either of the other two if the modern methods at hand are applied.



Well Designed BUILDINGS *Pay Their Way*

By H. K. Ferguson
President, The H. K. Ferguson Company, Cleveland, Ohio

RESEARCH is the keynote of modern progress. The orderly and patient searching for facts about the customer's needs, and for profitable ways to supply them, is transforming many conservative industrial concerns into responsive service organizations. The urge of competition is bringing forward countless new products and new processes. Old equipment is being rendered obsolete by new methods of getting better results at lower cost.

Chemical and allied industries have long held a leading position in this remarkable advance. Lacquers, rayons, dyes, metallic alloys and many other groups of products are all results of chemical research. Each has called for the development of new processes and equipment, all of which had their beginnings in the chemical research laboratories. Many of the newer plants that have grown up around these products are models of production efficiency, and are setting the pace for industry.

Builders of the newer plants have had the advantage of seeing their entire problem of plant design at the same time. Before ground was broken or equipment was purchased the entire process was laid out. Building engineers worked with production executives to make every structure contribute definitely to economy of manufacture. The best ideas of modern engineering were employed in the design of the buildings.

On the other hand, many of the older plants in the industry have grown up around a single process. Additional units have been added from time to time. Buildings have been employed to house portions of the plant that required shelter, and little attention has been paid to operating conditions. As a result, many plants have groups of disconnected buildings that may hinder rather than aid production. The emphasis was on the flow sheet and the technology of the process, and the buildings were allowed to take care of themselves.

It is interesting to note that in the mechanical industries, where methods and equipment for many years have been more or less standard, the tendency until recently has been to think of a building merely as so much floor space. Modern methods of handling for quantity production have now forced the executive of the mechanical plant to take a new view of his problem. He has learned to lay out his plant first and then design his building so that it will be a useful tool of production. He started at one end of the problem and the chemical manufacturer started at the other. Both are arriving surely at the correct solution.

Equipment is the major item of expense in a chemical plant. The units are heavy and bulky and must be arranged in proper sequence. Few men are required in their operation. In one large plant three men operate a complete sulphuric acid unit worth $350,000. It is quite natural under the circumstances that buildings should be considered as extra expense, and that scant attention should be given to proper working conditions.

Full co-operation of the operating organization with the building engineer will reveal many interesting facts about methods to make a building pay its way. A good building engineer knows that lower manufacturing costs are bound to result from adequate provision for light, ventilation and accessibility of apparatus for operation and servicing. He knows also that a number of detached buildings are more expensive than one building of uniform cross section because of the greater proportion of sidewall area for a given floor area. It is often possible to devise ways to modify the layout so as to group equipment that needs frequent service in one building, and provide a traveling crane for handling heavy parts that must be removed for repairs.

In one well known chemical plant that operates 2,240 electrolytic cell units, six men can service 35 units in a single day of eight hours. Formerly it took four men two days to service four similar units. The increase is possible because the process is now housed in a new building equipped with a crane. Piping and wiring are

located in the trusses or under the floor so that the crane can travel the entire length of the building.

If the units of equipment can be located on platforms or mezzanines along the sides of the buildings, with pipes and wiring in the space below, the entire space above is free for the operation of a crane.

It is an accepted fact throughout industry that abundant light is a distinct aid to production. A well lighted plant is an orderly plant. Greater speed and accuracy are possible when daylight floods every part of the building. Adequate ventilation for the removal of fumes is also good economy. The life of a building can be materially prolonged if scientific means are provided for changing the air at a definite rate. Careful study and selection of the materials used will also result in lower maintenance cost.

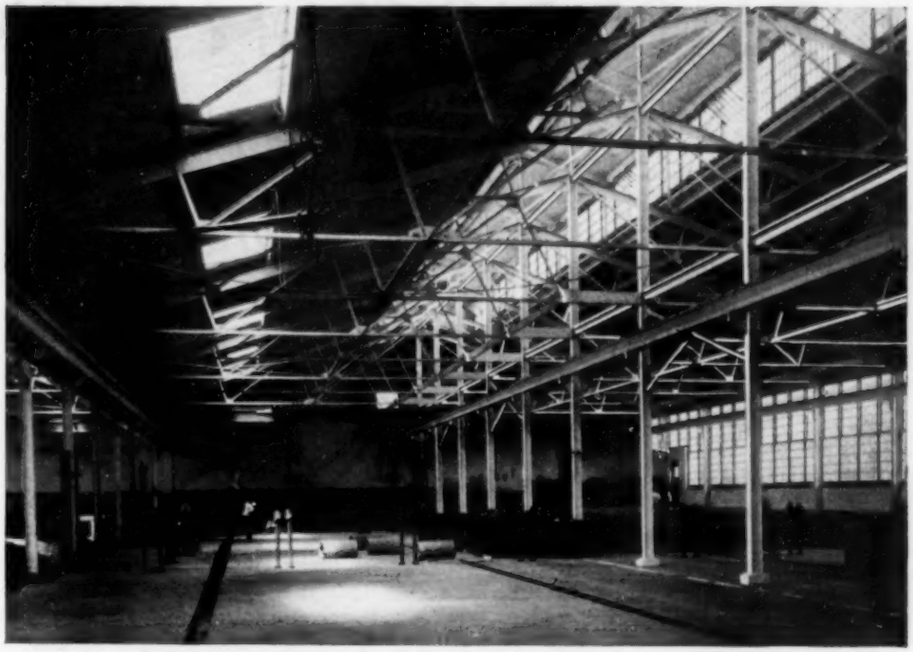


Fig. 2—Provision for cranes in this building has saved the owner many times the expense in the reduced cost of servicing the equipment in the building

These provisions all contribute to safer and more tolerable working conditions for the personnel of the plant. Reduction of accident risk and of labor turnover, plus direct operating economies, can easily pay the slight difference between the cost of dark, cramped, malodorous dungeons, and buildings designed according to modern standards.

Modern engineering favors one-story construction for most purposes, when sufficient property can be had. Interior columns are eliminated by the use of clear span trusses, or are spaced on centers of twenty feet or more lengthwise of the building. This gives freedom for the location of most equipment. The sidewalls are mainly of glass with as many ventilated sections as possible Steel or wood sash are used according to the intensity of the corrosive action encountered. Additional light and ventilation are obtained if needed through a roof monitor or by means of skylights and ventilators.

Multiple story buildings should not be much more than sixty feet wide if good natural light and ventilation are needed. The spacing of interior columns is planned to permit economy for the loading that will prevail.

The value of clear working space has led to the location of stairways, toilets and elevators in service wings at convenient points along the side of the building. This method leaves the floors free for productive use throughout the length of the building.

These and many other points that contribute to better operating conditions can be incorporated in the design of plants if the question of building is given its share of consideration during the early stages of planning. After the layout is determined, changes are very expensive and usually result in loss of production. The same type of research that has kept the products of the chemical industry at the front will reveal ways to put the buildings also into the class of useful, dividend-paying tools.

Fig. 3—Modern design calls for unobstructed, well lighted and "open" buildings. Stairways, elevators and toilets in service wings leave all floor space free for productive use

PRODUCTION CONTROL

An Essential Tool of Modern Business

By George A. Prochazka, Jr.
East Orange, N. J.

A BUSINESS is a cumbersome organism. It gets up momentum slowly and once it gets going it is difficult to change its direction. The fundamental idea in running a business is to find out thoroughly just what you want it to do, put the effort behind it to make it do this and then spend your time in seeing that the work is properly done.

In some manufactures keeping production in harmony with sales is held to be a difficult art. Elaborate control boards have been devised to insure the production of separate parts at the right time. Personally, although I have tried a number of boards I was never impressed by them in any other way than that they seemed to keep a clerk extremely busy. Not only is it difficult to tell whether the device is up to date, but it also shows little or none of the past events. These disadvantages led me to the adoption of the simpler and more effective graphic methods for production control.

In the sale of goods we are apt to overlook some of the important elements which enter into the determination of profits. When the production and the sale of an item runs along in fair volume at a uniform rate we can reduce our profit increment to a small figure, but when either of these criteria is subject to abrupt changes we must increase our profits to compensate for higher burden costs which are not fully revealed by the usual cost finding methods. Properly constructed graphic charts not only give us the needed data for correct profiting, but also provide us with simple means for correlating the two major parts of a business.

The figure shows a chart which I have used for many years in production control work. Daily Record Sheet 4217, published by the Codex Book Company is particularly well adapted to this purpose. Before we can begin such a diagram we must have a clear idea as to the quantity of goods we really can sell during the year. This amount is broken down into four parts, equal in value or adjusted to meet the seasonal variations in sales during the four quarters of the year. This term has been selected because a month is too short for production planning and the year or half year is too long for effective work. Using the adopted quantities we draw four quarterly quota lines as shown by the sloping dot and dash lines in the figure.

The sales graph is made cumulative just like the quota line. The sales of the day are added to those of the preceding day to obtain the stepped line marked "sales" in the chart. We start from zero at the beginning of each quarter. After the first term the quarterly quota line is supplemented by a yearly quota line so that we can establish our lead over, or lag behind the estimated sales for the full fiscal period. The dotted sloping line in the figure shows this auxiliary guide.

The production graph is drawn in a similar manner. At the beginning of the year we plot the sum of the finished stock inventory in the warehouse and the work in process inventory in the factory. This value is carried along horizontally, like line 776 in the figure, until a new batch is started. When lot 777 is begun we go up vertically an amount equal to the potential addition to the inventory. The same procedure is followed for all subsequent batches started. The second, the third and the fourth quarters are drawn in the same way.

When the yields are checked and we find a surplus or deficit variation from the standard yield per batch, this gain or loss is injected into the diagram by raising or lowering the horizontal portion of the production graph an equivalent amount. Discrepancies in the finished stock inventory are corrected in a similar manner.

In using this diagram for production control we simply observe the trend of the production and sales lines and govern our actions accordingly. Careful studies of such charts covering the events of a number of years will shed much light on the proper conduct of the enterprise. This diagram is not intended to give information on goods available for immediate shipment and, therefore, to differentiate between the factory and the warehouse inventory adds a useless complication to the chart. These facts can be obtained from the stock records.

After a schedule has been laid out it should not be altered before the end of the term even though we pile up a substantial inventory. This observation is to some extent theoretical for the reason that not all of us have money enough to run our business on this scale, but must depend on a little more nimble jumping from one thing to another. It does, however, outline the correct principles for the conduct of an enterprise. If we cannot plan our production for a period of three months and carry it out, then we are operating our business with too little money. This maladjustment often can be corrected by a little weeding of our products.

To plan a production campaign and to see that all of the component elements for its execution are available at the proper time is no small undertaking. Even when it is well done we are apt to encounter that distinct annoyance of having a call from the factory for certain things which must be had if we are to prevent the shutdown of a number of departments. Not so long ago I witnessed this while visting a carefully run plant and I must confess the sensation made me feel quite at home. A factory must be run with vision to the future, if smoothness of operations is to be attained. Chronic

changes in the manufacturing schedules make for that feeling of upset under which no one can work.

SIMILAR methods can be used for the control of raw materials although not all stock can be checked profitably in this way. There are four approaches to the raw material problem. We have materials obtained at all times from a conveniently located source of supply; in contrast to this we have materials that come from distant points or that are obtained at times with great difficulty. We also have expensive raw materials used in exact amounts and cheap raw materials used in that irregular way which is characteristic of many supply items. Naturally, in everyday business we have many intermediate variations of these four extreme conditions. Low-priced raw materials used in more or less uncertain amounts can be controlled best by ordering against a minimum stock quantity and some of the expensive ones can be handled by ordering exact amounts as needed. Moderate priced materials, or those that are obtained at times with great difficulty, or those that come from distant points are amenable to the graphic controls shown for production and sales.

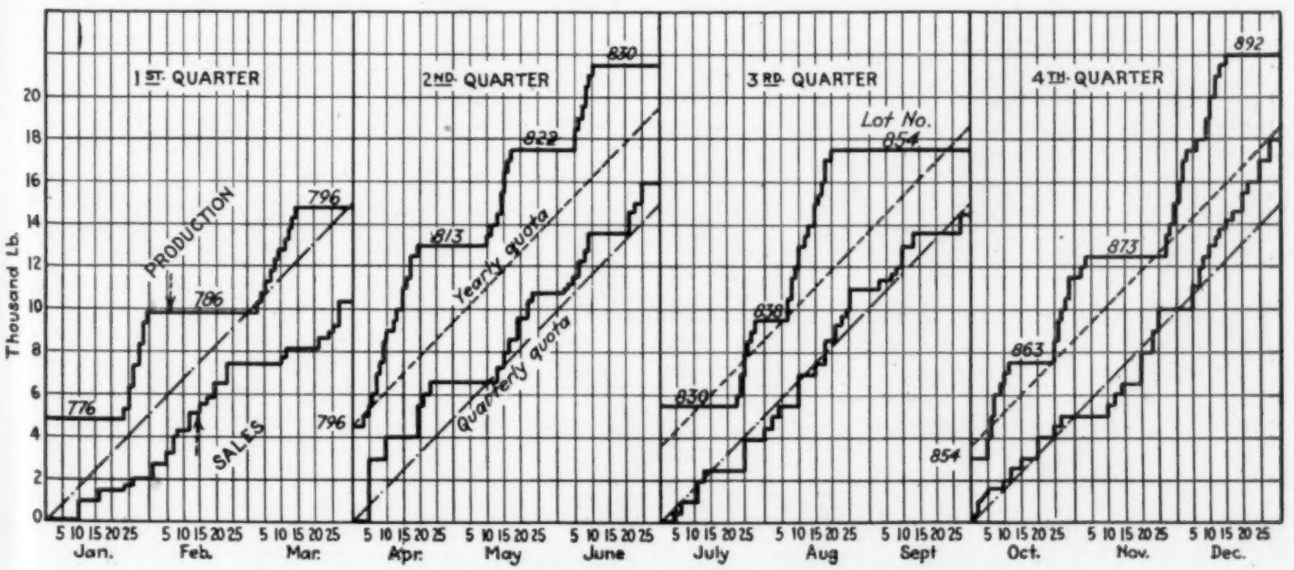
Many elaborate, detailed labor charts have been proposed and tried. These controls may be excellent in some cases, but as a rule when we try to turn a man into a machine we sacrifice that most valuable of all things—human judgment. Without this some of the most carefully laid plans go awry through the most trivial incidents. To test this thought, all we have to do is to go among some of our large corporations where the men have been made into automata and see how little the average employee knows beyond what is printed in a book of rules or is set up on some queer form that no one understands. Details, such as those pertaining to labor, must be brought to a focus at the earliest possible moment by some one with the power to act and his reward must be sufficient to obtain his full co-operation and interest.

Getting out production is closely related to having machinery in good operating condition. Maintenance work is regulated into precise channels with some difficulty and consequently controls for this are not easily established. Designing to eliminate unnecessary activities, people often check repair jobs by an order system. No work is permitted without a written requisition. As this procedure retards progress, standing orders are issued to permit prompt mechanical service being rendered.

There is no room for argument against the need for controlling maintenance work by an order system; but there often is room for improvement in the methods used to carry out the scheme. The vast amount of detail of a non-repetitious character occurring in maintenance work easily can make machinery controlling methods more costly than the very repair work itself. As we reflect on the upkeep of a plant we become impressed by the fact that some of it is of an incidental, nondescript character whereas other items assume very large proportions. Neither of these cases is particularly annoying in a work order system; but it is rather those events that fall into the middle ground which give us all our trouble. What is probably one of the best solutions to the problem is had by grouping the work into classes, obtaining the cost for each class and then working back into the underlying details whenever conditions indicate the need for a more searching inquiry.

If this scheme is adopted then it is unnecessary to cost each work order separately; but it is essential to keep a careful historical record of the important features of each sizable job. From these statistics improved designs for machinery can finally be evolved. By reducing the amount of the maintenance and repair work we can most effectively reduce the amount of control work.

PRODUCTION control is one of the essential tools for the building of a smooth running business. The reason for this is to be found in that when we try to regulate our manufactures we must map out for ourselves exactly what we are trying to accomplish, and the minute our aims become definite the thousand and one difficulties which are the natural concomitant of the indefinite disappear. Further, when we try to plan and control production our efforts become orderly. The important rôle which order plays in business should never be overlooked. The genius may be able to accomplish the impossible in the midst of his disorder, but how many of us fall into his category?



A Suggested Form For the Graphic Control of Production, Sales and Inventories

This chart, taken from the author's forthcoming book, "Accounting and the Cost Finding for the Chemical Industries," illustrates a convenient planning method that is equally applicable to control of raw materials or other production variables.

OBSOLESCENCE
in Unit Capacity of Chemical Engineering Equipment

By C. P. Tolman
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OBSOLESCENCE due to lack of sufficient productive capacity per unit applies particularly to equipment for treatment of material in bulk. This phase of obsolescence is therefore of special interest to the chemical engineering industries, in which bulk treatment is the rule rather than the exception.

"Obsolescence of Unit Capacity" is that which obtains when a unit of equipment is no longer economically useful because the volume it can produce is too small a part of the total volume of product required. The unit may otherwise be so perfect that the replacement should be exactly like it except as to size.

Among the bulk operations it may be well to mention several which are extensively practiced and which particularly lend themselves to the advantages of increase in unit size. The list is by no means inclusive and is given merely to suggest concrete examples which the reader may have in mind during some of the discussion. Among such operations we find—

Milling	Furnace Treatment
Grinding	Cooking
Separation	Digesting
Screening	Mixing
Pulping	Chemical Treatment

The type of obsolescence under discussion comes about when the required total volume of product outgrows the equipment of earlier times.

Few large concerns existed a generation ago. The total volume of each commodity was distributed among many manufacturers. The total volume of each of these manufacturers was such that it could be produced by three or four units of equipment. As time went on, volume grew and more of the same units were added. Mergers were formed or competitors were bought out, factories were consolidated and still more of the same units were gathered in to still larger "flocks."

DURING this period the character of management was changing. Personal management of small plants by owners "skilled in the art" gave way to management by executives better versed in finance and the distribution problems which were then coming to the fore. Meanwhile volume grew. Who was to say when the time had come to scrap the little units and buy or build sizes as well suited to the new conditions as were the little units to the work for which they were originally selected?

What transpired in the generation before the World War in respect to total volume per plant has since been practically doubled in many staple industries. Some of the larger industries are still using aggregations of small units which were designed to fit small factories in which three or four of them did all the work with one "spare."

There is an economic ratio of unit capacity to total volume which can be quite definitely determined for any case. The electric lighting industry is foremost in recognition of this principle and foremost in low manufacturing cost because it has the courage of its convictions.

Assume that it is good sound business to install thirty identical units, each of five ton capacity, to grind, screen, treat chemically or furnace a total output of one hundred fifty tons of a staple commodity. Let us further assume that three of these units were used, say thirty years ago, in a plant of fifteen tons total output. Did the owner of the original plant make a sad mistake? Was his business sense defective and should he have installed thirty mills, each having a capacity of one-half of a ton?

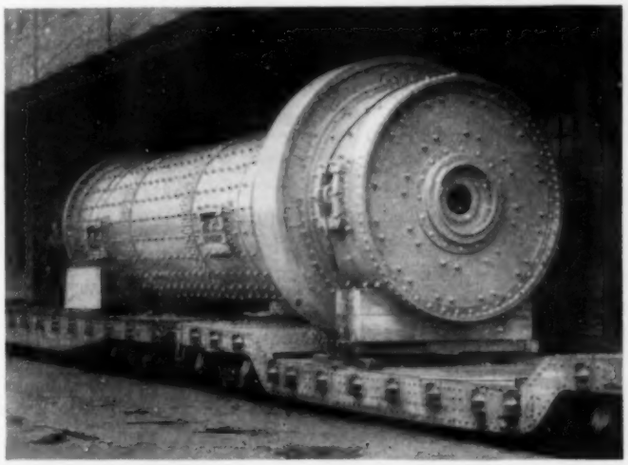
On the contrary, those men who laid the foundation of present industries when they built their small plants knew what they were doing. When equipment best suited for their needs was not to be found in the market, they designed it. They did such a good job that some of their old-time designs are being reproduced today. But the units are not the size that their progenitors would build today.

IN MANY plants the picture of the founder hangs on the wall, revered through several generations for his qualities of leadership by those who worked with him, and by those who respected the legends handed down to them—verified, as they were, by the machine—children of his genius living on and faithfully performing the kind and quality of work for which they were conceived. How unfortunate that, by the very perfection of such designs, the desire for progress which they expressed should be aborted. Instead of recognizing and embodying the principles in new equipment of adequate capacity, the technical performance of the original served instead as an excuse for complacent repose!

Fear of the capital requirement blinds those who cannot pass upon manufacturing facts to the tax of obsolescence upon earnings. The question can be answered best by showing the cost of this kind of obsolescence. Any business which can stand the drain of obsolete equipment and still pay dividends can well afford and easily finance the replacement of such equipment. Any business which is not paying dividends may well consider whether the deficit is due to obsolete equipment and, in such case, cannot afford to delay replacing it.

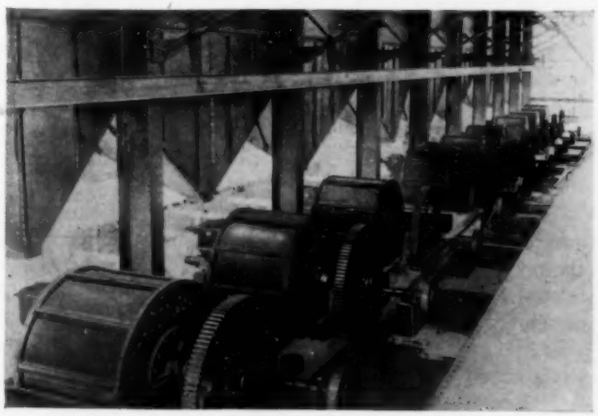
DEFICIENT UNIT CAPACITY is the most costly type of obsolescence. It carries with it a long bill of items and a total far exceeding—usually several times—the value of the equipment. Floor space occupied varies as the square of linear dimensions while volume increases as the cube. The capacity of most apparatus increases approximately with its volume. From these relationships it will be seen that as size increases the capacity runs up much faster than does the floor area required. Hence, a great saving in floor space is effected when a given total output is produced in a few large units as compared with many small ones. For example, let us compare four capacity units with twenty small ones of the same total capacity. The floor area of each of the large units will be about three times that of one of the small ones. The total areas will be as twelve is to twenty, a saving of two-fifths. To this saving must be added the saving in "working" area. Practically the same area is required for the attendant regardless of the size of the apparatus. Therefore four units will require about four-twentieths; that is to say one-fifth as much as the twenty and four-fifths will be saved. Saving in floor space applies to heat, light and items and services proportional to floor area.

Less labor is needed for four units than for twenty. In some instances, one man may run several units and the saving will not be as great but, in other kinds of work, the saving will be in direct proportion to the difference in the number of units.



An Example of Obsolescence of Unit Capacity

At the left is shown a modern, three compartment cement mill with a capacity of 150 barrels per hour. Below is shown the equipment it has replaced. Ten Gates mills (lower left) followed by ten tube mills (lower right) together have the same capacity of finished product.



Whatever kind of work a manufacturing tool is doing it must be supplied with material and its product must be taken away. When treating bulk materials this means today that some kind of conveying system is required. Needless to say it is simpler and cheaper to supply few units than many. If a dust or fume problem is involved, to insure sanitary working conditions, this problem is simplified and better success assured almost in direct proportion to the reduction in "outlets" which must be protected.

Fewer total parts means less to maintain. When the designs are similar, except as to size, the maintenance decreases almost in direct proportion to the number of units. Parts cost more for replacement when they are larger but this is more than offset by the more generous design which can well be afforded. Cost of inspection, lubrication, adjustment and cleaning all decrease in proportion to the decrease in number of units. When relatively valuable material is being treated, the loss of values in the daily clean-up will be a tidy annual saving.

When the units are driven by individual motors there is substantial saving in first cost of the fewer motors of larger horsepower as compared with many motors of lesser power. The total rated horsepower is less because the larger units and motors are more efficient. The margin allowed for overloads amounts to a larger total horsepower with many as contrasted with few units, and this further reduces the total horsepower required for the larger units. Line shaft drives favor the larger units in first cost, maintenance and continuity of service. Whether driven by motor or line shaft the annual power saving for the few large as contrasted with the many small units may run from ten per cent to fifty per cent, depending upon operating conditions. When alternating-current motors are used, the larger units will have a higher power factor. When the horsepower of the motor is large enough, synchronous motors can be used in place of induction motors. This will advantageously affect the power factor of the whole system.

An operator supplies watchful intelligence and control for a manufacturing unit. Whether it be of large or small capacity, the same amount of attention is needed. Hence the labor per unit of volume decreases as the capacity of the unit increases. Why have twenty men

"nursing" twenty units when four men can operate four for the same output?

When heat treatment is a part of the operation and loss by radiation is a factor, substantial saving comes with larger capacity units whether vessels or furnaces. This advantage is due to the fact that surface increases only as the square of the size, whereas capacity increases with the cube of the size. Hence, while a vessel of double size has four times the radiating surface, it has eight times the capacity. The radiating surface and, therefore, the heat loss becomes one-half as much per unit of capacity.

FLUCTUATIONS ARE STABILIZED and control is easier in larger units. Recording instruments and even automatic controls can be afforded for large units when the cost (which would be the same per unit) might prohibit such installation on units of small capacity. Because it is easier to watch few than many—to test few control samples than many—it naturally follows that a better product will come from few large units as contrasted with many small ones. There will be less spoilage and better quality. Although the average quality of a chemical product might be the same in two cases, the deviation from the average—plus and minus—will be less with large units.

Even in a going plant, the cost of replacement of units of old time size by suitable equipment is negligible as compared with the capitalized saving thereby to be realized. How much more important proper unit-capacity becomes when the total plant output must be increased! What engineer has not seen large sums sunk in bricks and mortar to house further addition of small units; these small units—obsolete as to capacity—being newly built duplicates of designs a generation old. A small part of the capital sunk in bricks, mortar and costly operation would finance the development of units suited for present conditions and low cost operation.

When plant increase is contemplated, the obsolescence in unit capacity should be sought out and corrected. When this is done, there will be room enough and to spare for the new capacity in the old building. Large units mentioned so far have been taken as larger sizes of the same design. The discussion was kept within these limits to avoid confusing the issue. Opportunities for substantial betterment often come with larger units. While such improvements are not needed to justify the main proposition, these opportunities should be sought and full advantage taken. Such possibilities are:

- Recuperation of heat (not feasible with small units spread over large area).
- Power (electric or other) for operations now done laboriously by hand.
- Installation of automatic controls.
- Mechanical handling of feed and discharge.
- Adequate control of dust and fume for reduction of fire, explosion or sanitary hazards or for preventing waste of material.
- Better handling of wastes or by-products because of concentration in larger unit volume.
- Better facilities for repairs and maintenance warranted because of capacity of the unit.
- Conversion of "Batch" to "Continuous Processes."

Some industries are now using the largest sizes of equipment which the market affords and yet these units are obsolete for their conditions through lack of sufficient capacity per unit. The savings to be realized by installation of units of sufficient capacity are such that the concern which is so to profit should be willing to pay the cost of development.

The cement industry affords an excellent example of increase in unit capacity to meet larger volume requirements. The kilns, pulverizers and incidental equipment have all been substantially increased in the course of the last few years. Meantime, betterments have been introduced which have not only improved the product but also the working conditions. A "dustless" cement works is now an established fact. According to the report in "Safety and Production" by the American Engineering Council, the cement industry from 1920 to 1925 increased production per man-hour thirty-two per cent and meanwhile decreased accidents to employees twenty-nine per cent in frequency and thirty per cent in severity.

Flour milling practice is interesting because the continuous process was worked out years ago while the size of units has long since been outgrown. New development is needed in this industry to provide it with units of much greater individual capacity and so better suited to the volume output of the average plant.

Ore crushing machinery has been brought up to as large unit size as will be needed for years to come. The Allis-Chalmers' units at the Chile Copper Company mines will each crush thirty-ton carloads faster than they can be dumped with a car tipple.

INCREASE IN CAPACITY of unit need not be limited to larger size of the same design. Many processes which are now carried on in "batches" can be made "continuous." The possibility of converting to continuous process should always be investigated when dealing with unit capacity obsolescence. The gain in capacity per unit by the continuous method is but one of its many advantages.

More than a decade ago the steel industry wiped out capacity obsolescence in the blast furnace department by designing larger capacity units. The 400-ton furnaces which were the prevailing size at the time were replaced by 800 and 1,000-ton furnaces, which are in general use today. "Hot metal" cars in which molten metal is transferred from blast furnaces to point of use were first built in units of fifty tons capacity. This unit capacity has since been increased to 150 tons, and the metal will remain fluid for more than two days. Continuous rolling processes are well-known for the remarkable increase in capacity which has been effected.

Power generation equipment is an outstanding example of anticipating unit capacity obsolescence. When, thanks to the courage and genius of F. S. Pearson, the first direct-connected unit was built, a program of size development began. The capacity of that original unit was 250 kw. Today we are thinking of a unit one thousand times as powerful.

It is neither desirable nor particularly helpful to give examples of bad practice. No two conditions are exactly alike and some vary widely. Enough has been said to demonstrate the waste by showing the savings to be realized by fitting the unit to its work as regards capacity as well as in respect to its technical duty. Batteries of multiple equipment should be put on the defensive to justify their continued use. A thorough investigation should be made because such an installation is probably obsolete and costing money every hour it runs.

Active search for obsolescence is the keynote of present industrial activity. Industries will prosper or fail largely as they anticipate and correct obsolescence, or are overtaken by it.

COLLOID MILL

Increases Capacity, Improves Quality, Lowers Costs

By P. M. Travis
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INDUSTRIAL application of colloidal chemistry necessitates equipment of a decidedly complex nature. Mechanical devices are beginning to be more important, and among those in recent years which excited a great deal of interest is the so-called colloid mill. A great amount of false claims and unsubstantiated statements have been made for this particular piece of apparatus. Approximately 80 per cent of its most efficient commercial use results from the proper knowledge of mechanical dispersion, and the applying of physical chemical principles, and only about 20 per cent is the result of the machine itself. In America there has been a lack of technicians trained to apply mechano-chemistry to industry, while the same situation does not exist on the European Continent. At the present day in the United States the field of mechanical dispersion is largely in the hands of equipment salesmen who seem to know very little about the basic principles upon which the machines work.

Usually dispersed systems may be formed in two different ways. Coarse material may be subdivided into fine particles; or in the second method, molecules may be condensed in groups so as to form colloidal size particles. Only the first method is truly mechanical dispersion, while the second is the result, ordinarily, of electrical and chemical methods.

In this particular article the primary interest lies in accomplishing mechanical dispersion by the use of the colloid mill. This machine is often spoken of as a homogenizer. It is distinctly different, however, from the pressure type or pump variety of homogenizer which has been used largely in the dairy industry for a number of years. Dispersion or emulsification is brought about in the colloid mill as a result of hydraulic shearing by the use of high peripheral speeds.

DEMAND for better methods, with greatly increased capacity and improved quality of products, has caused the rapid development of the colloid mill. Disintegration of solids is often claimed by mill manufacturers. The so-called colloid mills do not actually grind, however, what they really do is deflocculate. In a large number of cases this is all that is required. For example, when zinc oxide is first made, it is produced in a very finely divided state. In the packing of the material, the particles are grouped together into larger aggregates. When these aggregates are passed through the colloid mill in connection with oil, the aggregate is dispersed into its original fine state. Obviously, this is not a case of grinding, but of deflocculation and wetting of the individual particles by the oil. It is true that the particle is apparently ground.

Most investigators in the field of dispersion mills have realized that high peripheral speed was necessary in order to obtain proper hydraulic shearing action. This is the key to the situation in colloid mill development. Contact between rotor and stator is not desired, but a thin film of liquid between such surfaces must be maintained in order to utilize the proper hydraulic shearing action of high speeds. Methods of obtaining this shearing force in the various types of colloid mills differ considerably. Practically all of the manufactured mills of the present day are based on the principle of films, in which the shearing action is exerted between a rotor and a stator. They may be sub-divided into the roughened surface and smooth surface types. The smooth surface type may be further sub-divided into two groups, in one of which the liquid is forced through the gap by centrifugal forces acting upon the material constituting the film. Many such machines have working faces in the form of discs or flattened truncated cones, diverging, usually at a slope, from the ingress end.

At high r.p.m. there is considerable increase in the peripheral speed from the small to the larger diameter of the cone. In the second class of mills the surfaces confining the material are so shaped that the inertia of the film does not tend to evacuate the space between rotor and stator. In the second sub-division of the smooth surface mill the film at times actually tries to work back to the point of feeding, at least that is what the design attempts to effect.

A LARGE GROUP of mills is the roughened surface type, which is one of the most recent developments. This group may be further sub-divided into the variety in which a liquid is propelled to a gap by centrifugal forces acting upon the material forming the film, in which the rotor is a truncated cone diverging from the ingress end, but with grooved surfaces on both rotor and stator. Facilities for creating counter pressure are usually provided in the machine. In addition to hydraulic shearing action, eddy currents also result from the rotation of the grooved rotor or chopping action on the particles being treated. In addition there is also the resultant force created by counter pressure. While these mills have proven themselves quite satisfactory in some instances, they produce excessive heating. In some cases the power requirement has been greater than the dispersion accomplished by this method warrants. A second kind of rough surface mill employs discs rotating in opposite directions. In this case the product is subjected to the hydraulic shearing action and also a hammering action. Mills of this type are now commercially available. Their use is extending the many fields of application of the mill in industry.

To date no universal colloid mill has appeared. The selection of the type of colloid mill depends largely upon the problem involved. The ultimate colloid mill is yet

to be built. The claim is frequently made by manufacturers that their machines will reduce materials to a point where they will pass through filter paper. In reality, the pores of filter paper of most types are much larger than a micron in size, which is the usual dimension of most solids, plastics or liquid masses which are ordinarily commercially dispersed. In most commercial operations better results are usually obtained at clearances between rotor and stator of 0.006 to 0.008 inches, although many colloid mill manufacturers emphasize the point that their machines can be operated at a minimum of 0.002 inches. The clearances allowable will depend upon the viscosity and consistency of the product being dispersed. With large clearances, in the case of emulsions, the wear on the rotor and stator should be practically nil. In the dispersion of certain types of materials that are more resistant to shearing, the wear increases proportionately. In commercial operation, periodic relining of the mill is sometimes necessary.

Solids should be prepared for the mill so they will be 80-mesh or smaller. It should be borne in mind that the colloid mill is not a grinding medium, but rather a dispersing agent. Passing a material in contact with a liquid through the colloid mill markedly increases the wetting power of the liquid owing to the increase in surface area and contact between liquid and solid dispersed. The mill also removes the air absorbed on the surface of the particles. This is of great aid in wetting.

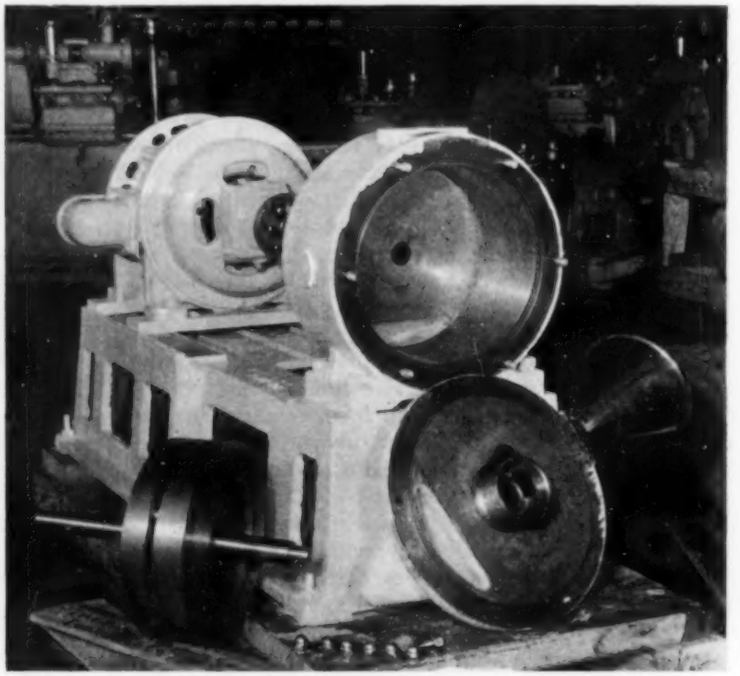
The essential in the commercial application of the colloid mill is proper knowledge of dispersion. Without information on peptizing action, dispersing agents, electrical charges involved and other characteristics, and of fundamental physical and colloid chemistry, the mechanical mill is not of much value. It must be used under proper direction and guidance. Of course, once any commercial procedure or routine be established, it can then be operated by workmen with entirely satisfactory results. Procedure must first be worked out, however, by someone very competent in the field and application of the mill to the particular problem in hand.

An emulsion is a system containing two liquid phases, one of which is dispersed as globules in the other. The generally accepted theory is that the formation of homogenized emulsions demands the presence of a stabilizing film about the dispersed phase. The particles are thus prevented from coalescing when they come in contact with each other through the activity of the Brownian movement. This protecting film is formed by the emulsifying agent.

PREPARATION of commercial emulsions is one of the rapidly widening fields where the colloid mill is being employed.

Types of emulsions are two in number, which are represented by the oil-in-water kind, and the water-in-oil variety. The first is the more common. In general, where the oil is dispersed in the water phase, with a concentration of the oil beyond 1½ per cent, an emulsifier is usually necessary. Often the emulsifying agent is already in the product, occurring naturally or associated with it. An example of this is butterfat dispersed in milk. The milk contains casein and lactalbumin, both of which are excellent emulsifying agents. The butterfat can, therefore, be readily homogenized in the presence of milk. Cocoa fat is readily emulsified in chocolate liquors, because the fine particles of cocoa powder can accumulate about the fat globules to form a sack or film, and also since such products contain protein materials which are good emulsifying agents.

Water-soluble colloids such as soaps, albumins, gelatin, glue, and nearly all water-soluble proteins, are good emulsifiers. Often their application in the solution of a problem, under competent direction, will be much more valuable than the operation of the colloid mill itself. Often peptizing agents which diminish the size of aggregate are of great assistance in causing dispersion, and frequently make it possible for the colloid mill to perform where otherwise it would fail. Small quantities of peptizing agents are of great assistance in increasing working power, which is most essential in fine dispersion.



A Commercial Type of Colloid Mill
The mill as disassembled shows the rotor to the left, the feed inlet through the funnel and the stator.

While colloid mills can aid in making dispersions, the dispersions need to be protected and stabilized. It is often necessary to use the so-called protective colloids, examples of which are gelatin, pepsin, and various types of gums. A large number of emulsifying agents can be used as stabilizers. If we mechanically disperse a material to a degree where the particle size is one micron, and a proper stabilizer has been added, the specific gravity of the material dispersed will have a decided effect, as well as the viscosity of the medium in which the material is dispersed. If the dispersion be made in a fairly viscous material, it will not show any settling tendency unless the dispersed material be of a very heavy nature. In general, suitable protection must be given to the dispersed particle, so that the proper potential difference may be maintained between the dispersed and the continuous phase and the viscosity of the ultimate product so adjusted as to offset the settling action. These factors

must not, under any condition, be overlooked if stable emulsions are to be obtained. Obviously, the colloid mill will not produce stable dispersions and emulsions if improperly used.

The commercial application of the colloid mill is just beginning. It is on the threshhold of an intense and widely varied development; the proper application of the mill is the crux of the solution. The emulsification of vegetable, animal, and mineral oils, as well as resins, waxes, and similar products, is quite typical of colloid mill application. The manufacture of water paint and calcimines can be greatly aided by the use of mechano-chemistry and the application of dispersion machinery. The colloid mill has been and is being used for the incorporation of pigments in paint, white enamel and lacquers, although in this field particularly has there long been the claim that colloid mills grind. Many of the problems in the paint industry will only be solved by the colloid mill when its application is connected up with a proper knowledge of the utilization of the machine. The extraction of solids, fats, resins, juices and similar materials from vegetable and animal tissues, is a field in which the colloid mill can make great strides, and be quite advantageous in its application. The field is almost a virgin one at the present time. Other general uses for dispersion mills are the purification of certain chemicals, liquids, and solids. The intimate mixing of ingredients and extracts and the making of fine suspensions of insoluble compounds, as well as mixing of creams, sauces and other food products; the dispersion of solids, such as mica, pigments, pitch, coal, and similar materials, into oils or other liquids all represent typical colloid mill applications.

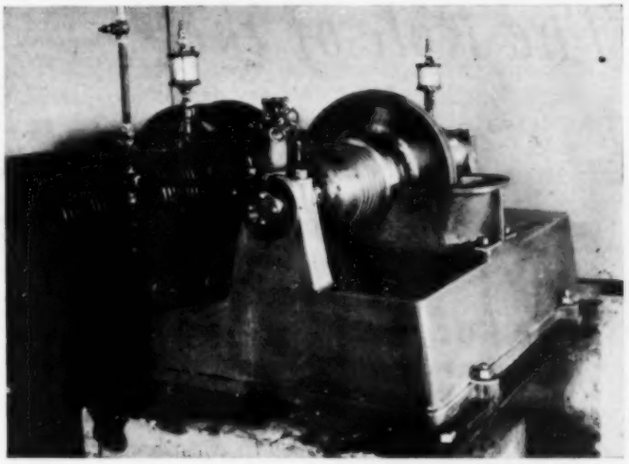
WHEN CARRIED TO the maximum by mechanical means, the resulting products frequently have new properties imparted by the extreme subdivision. In a number of chemical reactions, all that is necessary is to provide intimate contact between the various particles undergoing reaction. When two substances are dispersed by means of a colloid mill, the surface area and reaction possibilities are increased enormously. Hence, speeding up of chemical reactions often results from the use of the colloid mill. The velocity of the reaction is increased by the shearing action taking place in the machine.

Impurities in oils may be removed by emulsification, followed by the breaking of such an emulsion. The impurities remain in the water phase after separation and are thus removed from the oil. An example of this is the production of carbolic and cresylic acids from coal tar oils.

The recovery of pulp from old news print, wherein the stock is dispersed and de-inked in one operation offers a very promising future for colloid mill application. Where lithographing inks have been used, a slight amount of solvent in conjunction with the water phase usually is of great assistance. It is possible to completely remove the ink and coloring matter from such papers in continuous commercial operation.

IT IS POSSIBLE TO DO selective separation by use of the colloid mill where two products are mixed and one has been more or less adsorbed by the other. With proper operation it is possible to shear these products in such a way that gravity separation will follow. Such a process is now in commercial operation in the manufacture of pearl essence from fish scales.

The importance of the colloid mill is of far more consequence in connection with other equipment. An



Another Type of Mill
Here the uncovered mill shows the two rotors, driven in opposite directions when in operation.

example is the treatment of carbon inks for typewriter carbon paper. By first using the colloid mill for working the pigment with the molten waxes, a fine dispersion is obtained. This is ample for ordinary purposes, such as carbon paper for sales note books. In cases where there are hard particles of carbon, some of these will be completely dispersed, but the entire product will not be completely finished. Therefore, by running this type of product from the colloid mill direct into a ball or roller mill, a great deal of time can be saved in finishing, for when it enters the ball mill, it is, perhaps, 98 per cent dispersed. In such instances the two machines used together make an ideal installation. Work can be accomplished in far less time than with the ball mill alone. The output of the colloid mill is simultaneously improved in the production of a finish sometimes only obtainable with the ball mill. Capacity is increased for both units.

USE OF THE COLLOID mill with other equipment is a matter which should have been considered long ago. Through the desire of manufacturers to sell equipment, the machine's accomplishments were exaggerated in a great number of instances. Salesmen, instead of realizing that the mill should be used in conjunction with other equipment, emphasized that it, alone, could accomplish everything in fine dispersion. While in a great number of instances a colloid mill performs well by itself, its zone of operation and its field are expanded several hundred fold when it is used in conjunction with other equipment. There are very few branches of the chemical industry in which a colloid mill could not be used in some phase of the operation. This fact is now being appreciated by the larger manufacturers, and as a result, the colloid mill is demonstrating many new uses which a few years ago were thought hopeless. This includes applications in lacquers, in various heavy pigments, in the speeding up of chemical reactions, in de-inking of paper pulp, in dispersion of vat dyes, and in numerous other fields.

The chemical engineering employment of the colloid mill as a tool for industry is just beginning. Its technique is still young but rapidly growing. There is now developing a very active group of properly grounded and skilled operators who should be of usefulness to management. A universal colloid mill, of low power consumption, may be brought forth by the future.

The Rôle of the CHEMICAL ENGINEER *in Modernization*

By Harry McCormack
Armour Institute, Chicago

CHEMICAL engineers will play little part in the modernization of the chemical industries unless they are thoroughly familiar with modern process and modern engineering equipment. To make effective use of this information they must have such fundamental technical knowledge as will enable them to analyze processes and equipment on the practical basis of probable commercial success, operation and replacement costs, repairs, and quality of product.

The chemical engineer about whom this article is written is the one who is able to study a plant and its processes and say, "This process is modern, but is being carried out with obsolete equipment. These parts of your equipment should be replaced by — —— —. This process is obsolete; there is another, more modern one, which will operate at lower cost and yield a better product." This type of problem is least trying to the ability of the chemical engineer. Less simple are those problems in which the process is old and not very satisfactory but for which the development of new methods has been sluggish. In other cases equipment is not working satisfactorily, but manufacturers have had no great stimulus to produce standard equipment of better design.

The writer believes that ninety per cent or more of the problems in chemical engineering practice fall in the two classes used as illustrations.

The participation of the chemical engineer in the modernization of plant processes and equipment can best be illustrated by a few examples from the writer's own experience.

Pyroxylin plastics, mixed with fillers and color, and in the form of fine powder, were being prepared to be used in pressing certain articles. The old process consisted in putting scrap in an open metal box where it was sprinkled with solvents to plasticize it. The scrap was then transferred to metal cans holding possibly 200 lb. of material and was allowed to remain for several days to become thoroughly plastic. The plasticized material was then cut out of the can and mixed with filler and color on ordinary mixing rolls in 50-lb. lots. The sheets coming from the rolls were then suspended on racks in a heated room so that the solvent would evaporate. The dry, hard sheets were disintegrated in a series of three grinding operations. The sheets were first cracked up into small pieces, then ground to coarse powder and finally pulverized in pebble mills to a fine dust ready for pressing.

A review of this process indicates several possibilities for improvement. All of the solvent used was lost in the operation as conducted. This was quite an appreciable item. Considerable material had to be carried in process, as the soaking and plasticizing operation was a comparatively long one. The same was true of the drying operation on the milled sheets. It was decided that the plasticizing and the milling operations could, by the selection of the proper equipment, be done in one operation. It was also thought that after this blending of materials had been accomplished at least a portion of the solvent could be recovered. The process as operated today accomplished even more than was first thought possible.

The scrap with solvent and fillers is blended in a jacketed vacuum mixing and kneading pan, in lots of 600 lb. At the conclusion of this operation, the jacket is warmed up and the solvent driven off. As the solvent is distilled away, the mass in the mixer becomes drier. It also granulates so that at the end of the operation the mass is removed from the mixer in practically the same condition as it had been in the old process at the end of the first grinding operation. The new process takes hours, where the old one took days, and about 85 per cent of the solvent is recovered. It is to be noted that the solution of this problem was to replace an obsolete process with properly selected standard equipment being used by others in practically the same lines of manufacture.

An illustration of the advantage enjoyed by the engineer possessing a wide knowledge of equipment follows: Powdered materials varying in specific gravity from less than one to about two and one-half, some of them organic, some of them inorganic, were being mixed in the customary helical screw mixer. The time for mixing was about 55 minutes and the expense for maintenance and repairs was very high. A more satisfactory mixing machine was sought. Finally a peculiar type of concrete mixer was found which did the mixing satisfactorily in five minutes and with almost no expense for maintenance and repairs. The proper mixer would never have been found if the engineer had looked solely in his own industry, and if he had been familiar only with the equipment customarily used for the purpose he had in mind.

Another illustration of a problem which had to be solved in a somewhat different manner is shown in the manufacture of certain hard rubber articles. The process as originally operated consisted in placing the milled hard rubber stock in heavy cast iron molds, the cavities of which were alloy lined. The two sections of the mold were pressed together in a hydraulic press to accomplish the forming operation. Then these steel molds, perhaps thirty at a time, were placed in a vertical, steam-heated vulcanizer where they could be held under hydraulic pressure during the vulcanizing operation. The vulcanizing operation under these condition took about

three hours. This process was replaced by one in which the articles to be vulcanized were placed in chromium plated steel molds in automatically operated hydraulic presses. The vulcanization was then completed in a period of approximately forty minutes.

The influence of change in equipment and its effect on process is also illustrated by the vulcanization of another hard rubber article, this particular one being a comparatively large mass of hard rubber. The vulcanization was originally carried out in heavy cast-iron molds, alloy lined. The stock to be vulcanized was placed in these molds and the article formed under hydraulic pressure. To retain the pressure on the article, the two sections of the molds had to be bolted together with six bolts. The molds with their contents were so heavy as to be quite unwieldy and took up a large space in the vulcanizer. Replacement of the cast-iron molds by steel molds, the two halves of which are held together by properly made steel clips, has enabled a crew to increase its production about fifty per cent per day and has increased the vulcanizing capacity from forty molds to eighty molds in one vulcanization. In both cases we note the effect of replacing improperly designed equipment by more modern equipment, designed particularly for this specific process.

A comparatively new material of construction, that is, electroplated chromium, has also been of distinct advantage in bringing these two proceses into successful operation. Some rather complicated steel shapes were being formed under hydraulic presure in steel molds with a hardened face. It was found that the steel molds in the course of a few days wore to such an extent that the parts formed were not of accurate dimensions. Experience with rubber molds led to the belief that chromium plating the steel molds might decrease this wear. This was done and one mold now lasts about five times as long as it did prior to being plated. The extremely smooth surface of the chromium gives a better finish on the formed article.

Materials are available today for many purposes where the best materials of construction of the past were quite unsatisfactory. Nothing better was then known, so these materials had to be used. Processes which could not be carried out satisfactorily some years ago because satisfactory materials of construction were lacking, can now be placed in commercial operation with the equipment fabricated from the new materials.

CHEMICAL engineers to be of service in modernizing plant equipment today must be keen and comprehensive observers of various types of plant equipment in operation. It is possible to obtain some knowledge of plant equipment by a study of the equipment designs and by reading a description of it. It is impossible, however, to predict just how equipment is going to operate in a certain process until this equipment has been set in operation, either in this or some similar process. A chemical engineer is of greatest use to the plant contemplating equipment changes when he is thoroughly familiar with the various types which might be applicable to the process carried on in the plant.

A technical, analytical study must precede any recommendations as to change in process. It takes not only training, but experience, to study a process in this way. Determination as to which parts of the process are essential, which parts of the process are only incidental and from this basis predict the changes which may be brought about by varying process details or equipment items, is quite difficult.

A chemical engineer must have sufficient imagination to visualize the necessary plant layout and equipment from the description of a process. His imagination must cover fully the pieces of equipment necessary and proper arrangement in the process and how they may be operated. It must, however, stop short of the estimates as to cost of operation. These costs of operation must be calculated from a knowledge of present processes of a like nature now in operation or estimated from a knowledge of the cost of operating the various units which are assembled to make up the total of the process under consideration. In other words, the chemical engineer must not only be a technologist, but something of an economist and at least sufficient of an accountant to be able to ascribe proper figures to such items as interest and depreciation, taxes, supervision, labor and replacements and repairs.

MOST modernization programs require the expenditure of considerable money. The investors must have confidence in the integrity and ability of the engineer who makes the recommendations for changes. It is believed that these two characteristics are placed exactly in the right order, integrity first and ability second. No executive is going to accept the recommendations involving the expenditure of a large sum of money unless he is thoroughly convinced that these recommendations embody the best ideas and opinions of the engineer making the recommendation.

Competition, both domestic and foreign, has assumed such proportions that a decreased cost of finished product must be reached. Higher prices must be paid for satisfactory operatives. The only items which promise lower costs are more efficient operation of equipment, higher yields of product or lower costs of raw materials.

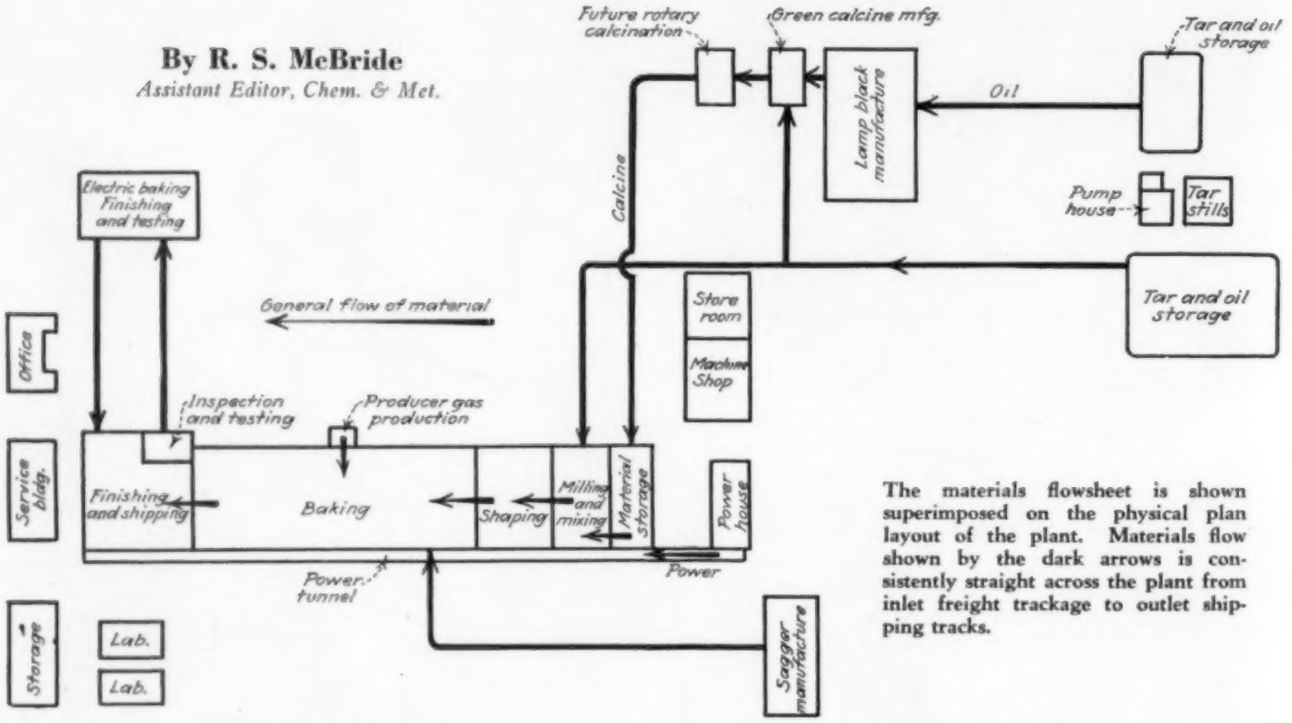
The chemical industries today more than any other suffer from equipment purchased either during the war when no other was available, or purchased after the war as second-hand equipment. It could then be secured at a marked reduction from the current prices for more up-to-date, more suitable machinery.

With a proper program for depreciation and replacement, this equipment should have all been written off of the industry's books during the past ten years. Now is the time, therefore, that it should be replaced with modern equipment. Much has originated or has been redesigned and greatly improved since 1918.

It has been the writer's privilege to have been somewhat intimately familiar with the operations carried out in a rather varied line of chemical industries. The feeling of complacency prevailing among some executives, engineers, and operatives has been appalling. They are familiar in most instances with the operations current only in their own industry. They do not realize that in allied industries or sometimes in quite different industries, processes and equipment are in use which would fit most satisfactorily into their own operations. To "sell" them modernization is the first job of the chemical engineer. To carry out the modernization program, to reduce costs and improve efficiency is the chemical engineer's opportunity to demonstrate the worth of his training and experience. He can only do this part of his job in industry if he himself keeps up with the procession by constantly acquiring ideas, thinking in broad terms and modernizing himself.

STRAIGHT LINE FLOW
Of Materials
Characterizes Carbon Products Plant

By R. S. McBride
Assistant Editor, Chem. & Met.



The materials flowsheet is shown superimposed on the physical plan layout of the plant. Materials flow shown by the dark arrows is consistently straight across the plant from inlet freight trackage to outlet shipping tracks.

MAKING carbon products is almost a "white collar" job in the new Fostoria, Ohio, works of the National Carbon Company. This plant began operations during 1928. Carbon products manufacture has been systematized by the application of widely useful modern ideas of planning and operating in the chemical engineering industries. Straight line flow of material through the plant is emphasized. Accurate co-ordination of succeeding process operations has been carefully planned. These coupled with good housekeeping and adequate care for the comfort of personnel are but a few of the management's ideas of this plant, which accompanies the latest type of construction and up-to-date engineering facilities. Together, these make the works an extremely interesting example of complete "modernization."

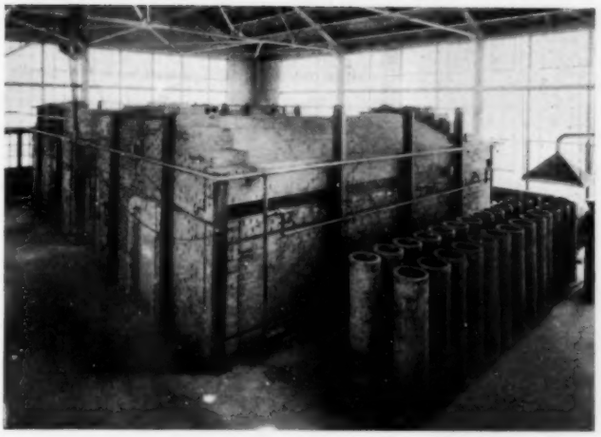
Carbon-products manufacture involves the preparation of raw materials for the use of the plant because of the quantities in which they are consumed and the special specifications required. Fostoria has a modern lampblack plant and tar distilling equipment inasmuch as lampblack is a starting material for many carbon products and special tars are used as binders. Clay containers, called saggers, must also be made for use in the major plant. These are built of selected clays to withstand the elevated temperatures employed in the baking operation.

The chemical engineering unit processes involved are distillation, heat transfer and heat technology, grinding and disintegration, mixing, pressing, material handling as well as the conveying of dusts, gases, pastes and liquids.

The term "carbon products" refers to those articles which are essentially carbon in their composition, made in a large variety of forms, and encountered in our industries as electrical machinery brushes, carbon contacts and the host of small carbon articles employed in the electrical industry at many and varied places; search light, blueprint and therapeutic carbons as well as those made for arc lights; the group of products known as specialties, of all diversities; and carbon tubes and small electrodes for ignition and radio batteries. Each of these finds an essential use somewhere in industry, and aids in our industrial operation and present-day progress.

Carbon products in general are manufactured from various carbonaceous materials, in relatively finely ground form, mixed with binders, made by various means into the desired shape, baked at high temperatures, and then machined or fabricated to the desired characteristics and forms.

MODERN FACTORY construction has been used in all parts of the new plant. Every section of the buildings is well lighted and affords comfortable working conditions. The management believes that such conditions should be provided and that all members of the plant staff will appreciate them and aid in their maintenance. They have good evidence of this in the



Making Containers for Baking of Carbon Products
A corner of the sagger making building, showing some saggers of clay, and some sagger firing furnaces.

experience at Fostoria, not only in the new plant, but in the remodeled old works. Living conditions for the personnel as well as land values were important considerations in the locations of the plant in Fostoria.

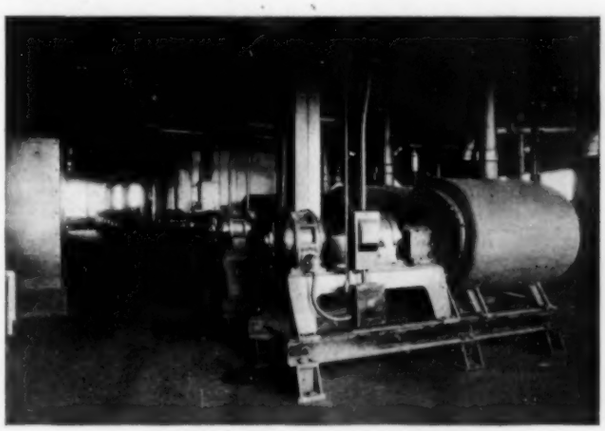
With the exceedingly large number of shapes and types of products, each meeting definite and relatively rigid specifications, it would seem to be almost an impossible task to co-ordinate all of these articles and their manufacture to a continuous straight line of production.

So completely has the system of straight-line flow been applied in this plant, however, that one can superimpose upon the ground plan of the work a theoretical materials flow sheet, almost without distortion. The raw materials enter at one end of the work on a series of incoming freight tracks and the finished product is received from the outgoing siding at the other end of the plant. The flow in between is consistently from inlet toward outlet trackage; cross hauling of materials is almost completely eliminated.

ANOTHER FACTOR of the systematizing of the fundamental plant operations is the elimination of "specials" from the main plant routine. Such odd jobs and small-lot operations are separately planned and managed under the division of plant control and are carried out with a special set of plant facilities. Thus it becomes unnecessary, whenever an odd-size brush or a carbon product of unusual electrical characteristic must be made, to disturb regular plant routine to accommodate such a job. When one realizes the multitude of combinations of size, composition, and electrical properties which may be demanded of carbon products, the importance of this management feature becomes evident.

One might think that this rigid adherence to straight-line flow would introduce complications due to the inter-stage storage of material. This effect has, however, been prevented by a proper co-ordination in the capacity and operating schedule for the equipment at each stage. The inter-stage storage is thereby maintained at the lowest point consistent with freedom from interruption of plant operation due to minor break-down in any particular unit equipment.

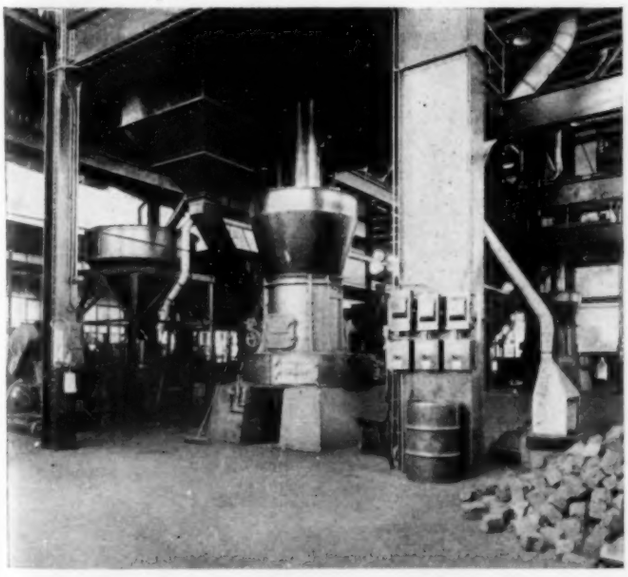
The ground plan, as well as the exterior views of the plant, shows how interstage movement of the materials has been simplified by placing five buildings in a group practically as one. The calcine milling, milling and mixing, forming, baking, and finishing operations are arranged in normal sequence and the structure for each is appropriate in size, head room, number of floors, and



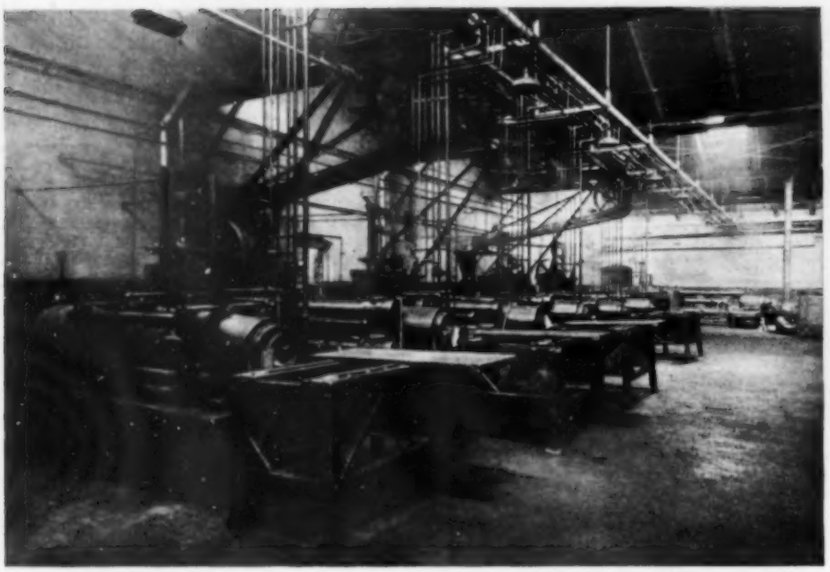
Part of the Mixing Room
Some of the mixers where the ingredients of the various articles come together to be made into the plastic mass sent to the presses.

type of construction. But each of these five buildings is really only a part of a single great plant structure. There is, however, distinct separation of the sagger making facilities in one building, the boiler plants in another, the machine shop and store house in another, and similar segregation of other special facilities which do not require such intermediate affiliation with the main manufacturing operations. For safety and fire protection, even greater separation from the main plant has been accorded to tar-refining facilities and to the lamp-black unit. All auxiliary buildings and facilities are, however, so placed that there is a logical straight-line flow of the materials and of the facilities and a negligible amount of cross-hauling.

ATTENTION has been given to every auxiliary detail to secure maximum life and maximum ease of maintenance or repair. Steam, gas, and other pipe lines, tanks and storage equipment, and much of the operating plant machinery has been assembled by welding. In many cases this construction has greatly



Disintegration and Pulverizing
Some of the Raymond mills used for grinding. Every precaution has been taken to keep what is ordinarily "the dirtiest hole" in a carbon plant, in a spic and span condition.



Alignment of Equipment and Machines in Modern Carbon Products Plant

At the left is shown a view of the extrusion room, where arc light "pencils" and similar products shaped by "forcing" are made. Along with forming presses, such as shown at the bottom of the page, these shaping machines are in the "press room," the "heart of the carbon products plant."

Views through the power tunnel, the baking department and of one of the main buildings are on the next page.

reduced the weight or size of equipment. In all parts of the plant, it has almost completely eliminated the problem of leakage.

Floor construction received special attention. Impregnated wood block, laid end-grain up, was chosen as giving the maximum of comfort and efficiency in a quiet resilient working surface, easily repairable at those few points where very heavy trucking will cause damage, and occasioning a minimum cost for maintenance.

The organization for operating the plant is of the staff and line type. Serving all the departments of the works, are the repair and maintenance shops, employment and personnel, the manufacturing (scheduling and planning) department and laboratories as examples, responsible to the operating lead of the works, but aiding all departments through the foremen.

RESPONSIBILITY for standard specifications and uniformity of product rests upon the works laboratory, which functions as an integral part of the plant. This unit is responsible for checking the quality of raw materials and for making tests while the various products are in process of manufacture. It rejects unsuitable raw materials and it follows the products through each step in its manufacture. The provision practically eliminates spoilage and assures finished products which meet the specifications laid down by the Company for its finished goods.

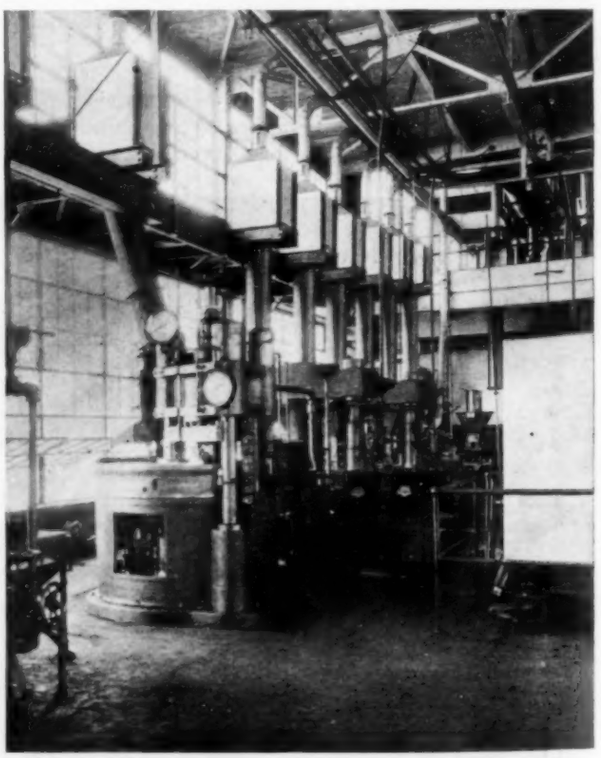
The works laboratory is also interested in improving manufacturing methods and in developing new products. In these activities it co-operates with the research laboratories which function for all the companies affiliated with National Carbon Company in the Union Carbide and Carbon group.

Provision and planing for facilities for the workers of the organization features the plant. In 1922, *Chem. & Met.* editorially quoted from one of its authors "on the absolute dirtiness of the average carbon plant." At Fostoria the industry has been "cleaned up" as far as is possible in an engineering sense. Every effort is made to keep the plant clean.

For example, facilities for dust control have been installed, with the result that the visitor is no longer offered a duster and urged to tie a handkerchief about his collar, lest he be unpresentable when he leaves. He is quite as safe anywhere in the works wearing a straw hat and a light suit as he would be in a candy factory.

In insisting upon good housekeeping methods, a clean plant and clean machines, the Company finds that a secondary benefit of practical value accrues. This lies in the fact that a sense of discipline and of the value of good organization is automatically instilled in the workers, with a consequent beneficial effect upon all their activities.

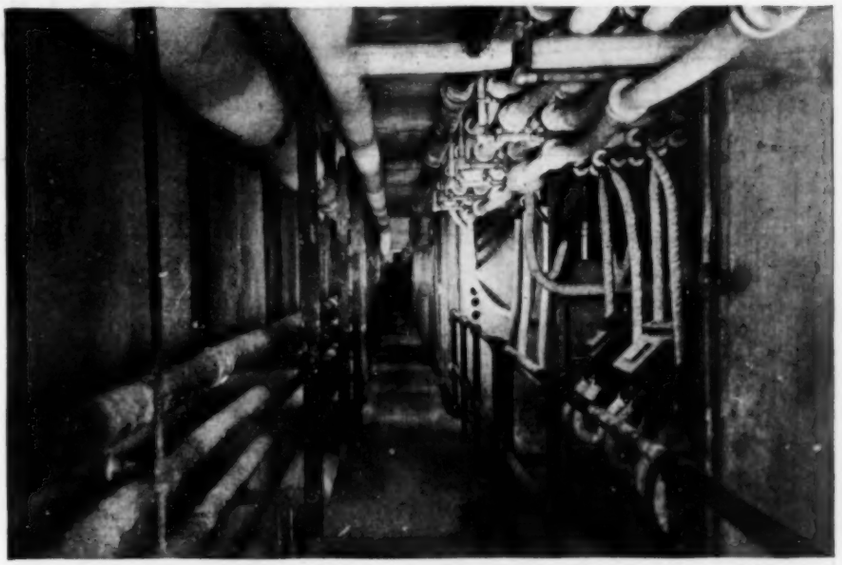
Carbon is black, and no amount of management planning would prevent persons handling it from getting dirty smudges on person and clothing. The worker does not object to this, however, if he has the proper



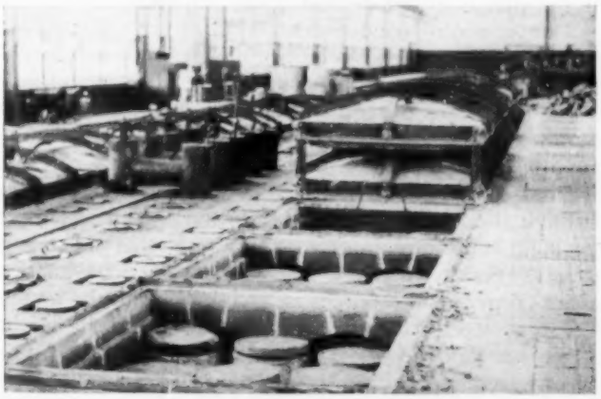
Semi-automatic Brush Forming Presses
Material flow to the presses is from the mixer room on an upper floor to the temporary storage hoppers seen above the presses.

facilities for personal clean-up before leaving the plant at night. At the Fostoria Works the best of modern equipment of this sort is available. Personnel facilities are grouped in a large, well constructed service building, of which the ground floor is devoted to locker and wash rooms and the second floor to the staff cafeteria. These facilities have been instrumental in actually changing the character of the carbon business.

The cafeteria when in complete operation, will afford facilities both for those who wish to bring their lunches and those who wish to buy them at the works. No distinction is made between the two groups; the one requirement is that lunches shall not be eaten elsewhere within the plant building. The cafeteria will be operated by a skilled management which will have the benefit of supervision and advice from the personnel staff of the parent company. It will be operated with the expectation of making no profit and incurring substantially no deficit. Hence, whenever skilled management and increased patronage provide a small surplus this immediately becomes available for lowering the prices, or increasing the variety of food furnished.



Tunnel Connecting the Power House and Other Parts of the Main Building
Steam, air, gas and water piping is laid out in straight lines. The greater part of the pipe line equipment was assembled by welding.



Where Carbon Products Are Baked
A view of some of the sections of one of the baking furnaces of the "ring type." The articles are packed in dust in saggers and baked. The gases in burning pass over and around the saggers.

In order that any contingency might be guarded against, even in case of serious fire, the plant is provided with its own fire pumps and a reasonable amount of fire-fighting equipment. The installation of these facilities was deemed important because on occasion the city fire-fighting equipment might be prevented from reaching the works at the maximum speed. All of the nearby city fire-fighting apparatus must cross over important railroad grade crossings to reach the plant. Occasionally those grade crossings are blocked.

When one realizes that even so remote a combination of circumstances as blocked grade crossings on the nearby railroads must be taken into account in the planning of the plant, it becomes evident that complete modernization of a works is not a simple task. It is equally evident, however, that only by taking account of every condition, both expected and possible, can such plant management place itself in a position of full security for continued efficient operation.

A Modern Type of Industrial Building
A view through one of the largest buildings of the plant. The open type of construction is particularly to be noted. Provision Provision has been made for rapid material handling by cranes and trucks.

REPLACEMENT
of Obsolete Equipment Shows Savings

By Theo. Schwarz
Durango, Mexico

AFTER taking charge of the oil mill and soap plant of the Compania Industrial Jabonera de la Laguna, S.M.L., Gomez Palacio, Durango, Mexico, several years ago, the author soon found that the production costs of the glycerine plant were excessive. The glycerine distilling plant consisted of two Van Ruymbeke distilling units, together with concentrating equipment, sweet-water evaporators and bleaching equipment. The plant had been in operation about twenty years and required frequent repairs. The steam consumption was excessive due to the nature of the equipment and process and to the large amount of sweet-water which required evaporating. The amount of labor required was high on account of the attention required by the two units. The operation was not satisfactory. It was frequently necessary to redistill large quantities of glycerine to bring the distillate up to the desired standard. Both C. P. and dynamite grades were being produced.

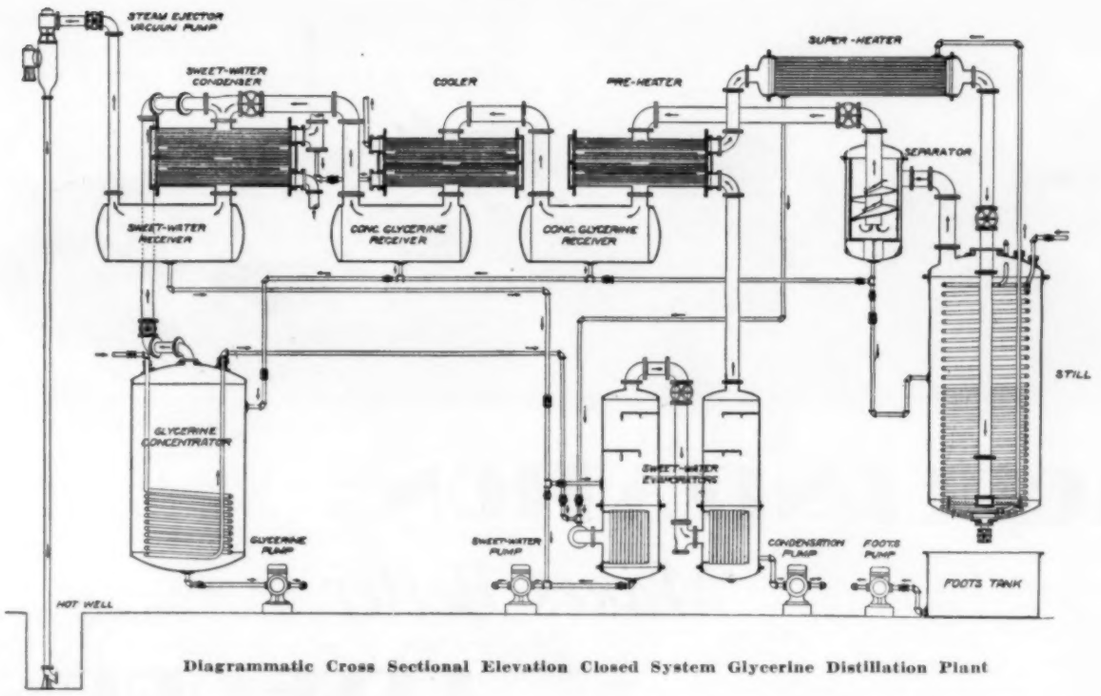
The subject of glycerine distillation was, therefore, thoroughly studied. Plants in the United States and Europe producing both dynamite and C. P. qualities were visited. After this investigation a complete new glycerine distillation unit was installed. This plant was put in operation in May, 1928. The complete plant was furnished by Wurster and Sanger of Chicago.

The results obtained with the new plant forcibly illustrate that the increased efficiency of new equipment more than pays for scrapping old equipment, even though the old equipment might be made to operate for some time longer. The important accomplishments of the new plant will be briefly enumerated. The steam consumption has been greatly reduced. Only two and one-half pounds of steam are now required per pound of glycerine distilled. The old boiler plant consisted of four 250-hp. boilers operated at 160 pounds pressure. These boilers were arranged in batteries of two each, or 500 hp. per battery, and the two batteries were used alternately.

NOW ONE BOILER of 200 hp. operates the sweet-water evaporators, the distilling plant, all pumps for these plants, several large water pumps and the sodium silicate plant which lies adjacent. The labor required has been reduced by over 30 per cent. The saving effected in steam consumption and labor alone will pay for the entire plant in less than two years' operation. The floor space required by the new plant is approximately 25 per cent of that required by the old plant—in fact, the new plant was installed in what was practically wasted space in the building housing the old plant, thus releasing most of the building for other work. The most notable result, however, is that the plant is producing C. P. glycerine in one distillation from saponification crude glycerine of average quality.

The essential features of the distillation system, which make possible the economies above outlined, will be briefly described. The line cut on the top of the opposite page shows a diagrammatic cross-sectional elevation of the plant. The plant operates on the closed system principle. The mixed glycerine and water vapors coming from the still preheat the injection steam going to the still. In this preheater, or heat exchanger, the first glycerine vapors are condensed. The subsequent fractional condensation of the mixed glycerine and water vapors is effected by two water-cooled condensers. The proper separation of the water vapors and volatile impurities from the condensed glycerine is automatically controlled by an automatic temperature regulator which controls the water supply to the cooler. The condensed sweet-water from the final condenser returns to the evaporator where it is evaporated under vacuum. The vapors, after passing through the preheater and superheater, are injected into the still. One important factor here is that there is no accumulation whatsoever of sweet-water since no open steam from outside sources is introduced into the system. The total sweet-water produced cannot exceed the amount of moisture in the original crude glycerine. As fast as sweet-water is produced, it is evaporated for re-injection into the still. All injection steam is generated in this way within the system.

IT IS TO BE NOTED that the vapor from the evaporator, which is injected into the still, is thoroughly expanded and superheated to the vacuum and temperature within the still before injection into the still. Mention has already been made of the fact that the glycerine vapors from the still preheat the injected steam. The temperature of the glycerine vapors coming from the still is, however, always lower than the temperature of the liquor in the still. Furthermore, the glycerine vapors coming from the still cannot heat the incoming expanded steam up to the glycerine vapor temperature. The effect of injecting into the still steam of lower temperature than the liquid in the still would, naturally, be to cool the contents of the still. The heat, not only to distill the glycerine but also to heat the injected steam, would then have to come entirely from the closed coil in the still. The capacity and efficiency of the still would, therefore, be decreased. This condition, existing in the original closed system type of glycerine distilling plants, has been overcome in the improved system. A high temperature direct steam heated superheater is used to superheat, to a temperature above the distilling temperature, the pre-



Diagrammatic Cross Sectional Elevation Closed System Glycerine Distillation Plant

heated vapor from the evaporator which is to be injected into the still.

The steam for the evaporator which generates the injection steam is the exhaust steam coming from other parts of the equipment, such as the superheater, the concentrator and the still. The great steam economy is, therefore, brought about, first, by an efficient system of heat exchangers, so that a minimum amount of high pressure steam is used to bring the crude glycerine up to distilling temperature, and, second, by evaporating the sweet-water as fast as it accumulates in the sweet-water evaporator with the exhaust steam from the heating coils of the superheater, concentrator and still, the vapors so formed under vacuum and preheated being further expanded and superheated and then injected into the still. This eliminates the necessity of evaporating sweet-water in separate evaporators outside of the distilling unit.

The concentrated distilled glycerine collects in the concentrator. As this vessel fills, the glycerine is brought to the desired concentration and pumped out without interfering with the distilling operation. The plant, therefore, operates continuously up to the point where it becomes necessary to remove foots from the still. The plant here described, operating on saponification crude glycerine, can be operated continuously for a period of one week.

The distilling unit is provided with an improved form of entrainment separator known as the Flick catchall and entrainment separator. This is one of the major reasons for the high quality of the distillate. Crude glycerine consists of 80 per cent to 92 per cent glycerol, water, volatile impurities and non-volatile impurities; the amount of volatile impurities is small and passes out of the still with the water and glycerine vapors. The temperature of the cooler is so controlled that the volatile impurities pass on and condense with the sweet-water leaving the condensed concentrated glycerine free of the volatile impurities originally in the crude. The non-volatile impurities should remain in the still. The redistillation of glycerine made by the old system was, however, largely necessary because of the presence in the distillate of non-volatile impurities. In other words, these non-volatile impurities are carried from the still by entrainment. The separator in the new plant has demonstrated its effectiveness in removing entrainment, for, as pointed out above, the plant is producing C. P. glycerine in one distillation.

Vacuum on the system is produced by means of a Ross two-stage steam jet ejector. This ejector maintains a vacuum within 1½ in. of the barometer on the entire system. A higher vacuum would, of course, be desirable, but is precluded in this case by the temperature of the cooling water available. It is outside the scope of this article to discuss the design and construction of the several pieces of equipment comprising the complete distilling unit, but it is pertinent to mention here that the plant was built with special regard to the necessity in a modern glycerine distilling plant of holding a high vacuum. (See "Refining of Salt Crude Glycerine," by W. E. Sanger, *Chem. & Met.*, Vol. 27, p. 827, 1922.) A steam pressure of 200 pounds is maintained at the coil inlet to the still. Under these conditions of vacuum and temperature the plant has been operating at approximately 100 per cent over its rated capacity based on a steam pressure of 160 pounds. The refining loss has been materially reduced with a corresponding increase in the yield of salable product.

Sight glasses installed in the glycerine and sweet-water flow lines enable the operator to see just what the plant is doing. The ability to control at all times the operation of the entire plant and the simplicity and accuracy of this control are outstanding features, from the operating standpoint. The simplicity and compactness of the units are evident from the illustrations.

From every standpoint, therefore, there have been material advantages resulting from discarding the obsolete equipment and installing the new plant. The production costs have been reduced. The refining losses have been decreased and the yields of glycerine increased. Less floor space is required. Most important of all, the quality of the product has been improved by the introduction of equipment of modern and improved design.

Plant of the Krebs Pigment and Chemical Company

MODERNIZATION *Makes Better* LITHOPONE

By Charles L. Mantell
Assistant Editor, Chem. & Met.

IN PAINT MANUFACTURE, the use of lithopone is increasing at a more rapid rate than that of the competing white pigments such as white lead, and zinc oxide. Last year the domestic production of lithopone was 176,974 tons, of which the greater part was used as a paint pigment. In the past the pigment found its principal use in the paint industry for interior paints, but due to the great improvement in quality in recent years, as a result of improved manufacturing processes, it is now being very extensively used as an outside paint, and consequently is displacing an equivalent amount of white lead. The future of lithopone in outside paint is very promising and undoubtedly the use for this purpose will increase rapidly.

It is surprising to find so many people, even among chemical engineers, who have little knowledge of lithopone. It is used principally as a paint pigment, but it also finds a large use in linoleum manufacture, and as a filler for rubber. The pigment is largely used for flat wall paint and also in a number of grades of enamels. As an interior white, a first coat white or as a pigment in a lighter shade of floor paint, lithopone cannot be excelled for its body, durability, hardness, fineness of grade and ease of application. Inasmuch as it does not oxidize progressively, this feature has made it of inestimable value to the table and floor oilcloth industry.

Making of lithopone is on a very large scale as exemplified by the production of 80,000,000 lb. per year by a single company, such as the Krebs Pigment & Chemical Company of Newport, Delaware. This plant is an excellent example of the results of modernization in the chemical industries. Only a decade ago, almost all of the handling of material, charging of furnaces, conveying of products around through the plant, and other operations were done by hand labor. At the present time hand labor is conspicuous in the plant by its absence. Material handling equipment has replaced human hands at all possible points.

Elimination of the obsolete is exemplified in the Krebs plant in many ways. For example, batch processes are used only where absolutely necessary, and in nearly all cases have been replaced by continuous operation. Mechanical handling and continuous processing are everywhere evident. The visitor to the plant is impressed by the great extent to which energy is conserved and called to function more efficiently. Modernization of processes and products has resulted in great advances of quality of the finished material and almost absolute uniformity of the same.

The location was evidently well studied in advance, for the plant is excellently situated in respect to the receipt of raw materials and the shipment of finished products. It is located on the Christiana River, which gives direct water connection with the Marine Terminal at Wilmington, Del. Access is thus available to direct steamer connection and easy foreign shipment. The plant is also served by railroad spurs for domestic shipments.

Lithopone consists theoretically of 29.5 per cent zinc sulphide and 70.5 per cent barium sulphate. It is made by mixing solutions of zinc sulphate and barium sulphide in molecular proportions in accordance with the following reaction:

$$Zn\,SO_4 + Aq + BaS + Aq = ZnS + BaSO_4 + H_2O$$

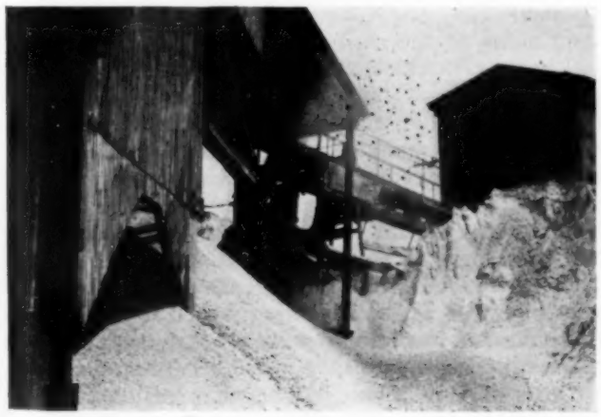
The precipitate formed as the result of this reaction has no body or hiding power. It requires exceedingly careful manipulation and treatment for conversion into a suitable pigment. After washing, drying and ignition to dull redness, followed by sudden quenching in water and grinding in its pulp state, washing and drying again, it makes an excellent paint pigment. It is brilliant white in color, exceedingly fine in texture, and has excellent

hiding power. When compared with pure zinc oxide, it is shown to have greater hiding power. Lithopone is stable in exery medium known and used for paint purposes, excepting those which are highly acid.

MANUFACTURE OF LITHOPONE is really the production of three different products, two of which become raw material for the production of the third. The barium sulphide is made from barytes, an ore whose principal constituent is barium sulphate, by reduction with carbon. The zinc sulphate is made from metallic zinc and sulphuric acid.

Barytes is received from two sources. Imported ore, in barge loads of six to seven hundred tons, is received by water. Domestic ore is received in box cars by railroad. The imported ore is shipped in bond. It is recovered from the barges by clamshell buckets, delivered to scales where it is weighed under the supervision of a customs inspector, then to crushing machinery, conveyors, and by the use of a "slinger" to the storage pile. The slinger is essentially a turbine rotor especially designed for the purpose, mounted on a turntable so that it can be directed in any manner desired. It is driven by a motor in an inclosed concrete pier which has been built hollow to facilitate inspection of the motor and the connecting gearing. The slinger has a capacity of 40 tons an hour, and delivers to the storage pile of 15,000 ton capacity over a radius of some 100 feet. The slinger is a most unusual and efficient material handling unit, and considering its excellent performance it is to be wondered that it is not more widely employed.

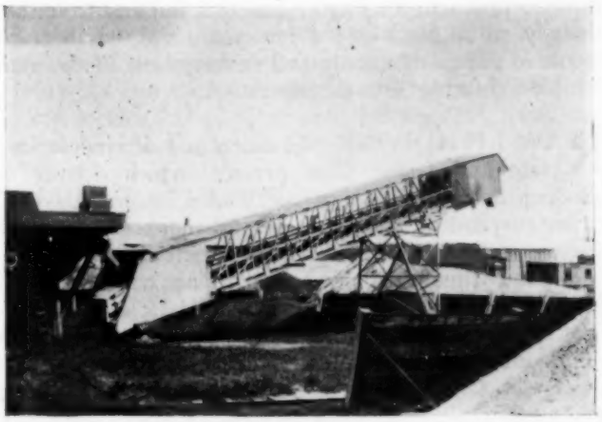
Domestic ore is received in box cars, and unloaded to an apron conveyor parallel to the railroad. The apron conveyor discharges to a crusher from which the ore goes to an inclined belt conveyor, the end of which is mounted on a track so that the discharge of the conveyor can be directed to various parts of the circular storage pile.



The Slinger Delivering Barytes to the Storage Pile
This unusual material handling equipment has a capacity of forty tons of rock per hour, delivering the barytes to the 100 foot radius storage pile of 15,000 tons capacity.

Ore is reclaimed from the storage pile by means of electrically driven wagon loaders. These discharge on to automobile trucks which carry the material to intermediate storage before the preparation of barium sulphide by reduction of the barium sulphate. Motorized service has completely displaced the former use of horse drawn carts, with resulting large savings in transportation costs.

Barytes is mixed with coal and reduced in revolving



Unloading Equipment for Handling Barytes from Railroad Cars to Storage.
The unit consists of an inclined belt conveyor, mounted on a trestle which travels on a semi-circular track. It can be thus made to discharge to any point on the pile.

furnaces to barium sulphide. The old and still used practice in some plants in the United States employed hand fired Dutch ovens for doing this job. The labor requirement is one man to every furnace per shift in this type of installation. In the Krebs plant, powdered coal installations have replaced hand firing, with a reduction of labor to one man for four furnaces per shift instead of one man per furnace per shift. Heat is carefully conserved throughout the plant, as represented by the installation of waste heat boilers in connection with these so-called "black ash" furnaces. The steam from these waste heat boilers is used in driers elsewhere in the plant. Inasmuch as some of the other thermal requirements of the plant do not call for the use of steam, but require hot air, waste heat from some of the black ash furnaces is used to heat air for tunnel driers employed elsewhere in the process.

In a number of places in the plant there is seen evidence of the influence of some of the operators who have previously had extensive experience in the metallurgical industries. Long before the chemical engineer began to think about handling of materials in large quantities, in a continuous manner, the mining and the metallurgical engineers had the problem solved and were applying them in their plants. One of the great factors in modernization of the chemical engineering industries has been the following of ideas from perhaps older industries, or from those industries which were required to handle large tonnages of materials.

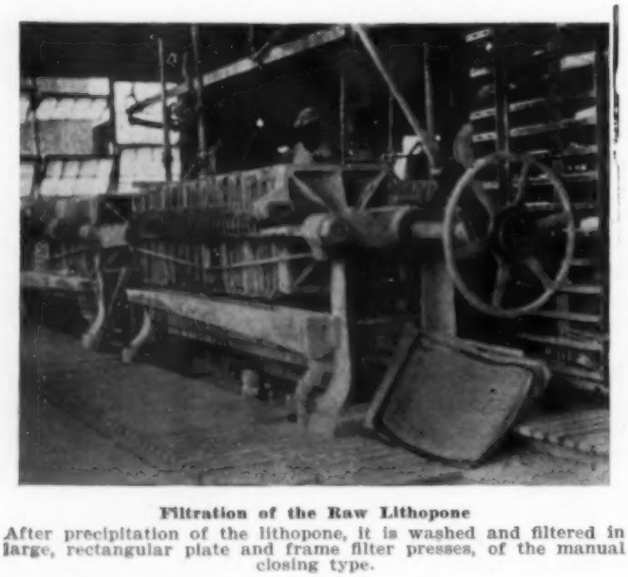
MAKING barium sulphide liquor is a continuous process. The old method employed lixiviation, which becomes essentially a batch process. In this plant, the black ash from the reducing furnaces goes to a roll jaw crusher, which discharges to a carrier elevating the material to a steel ball mill, wherein it meets a flow of water counter currently. The discharge from the ball mill goes to four Dorr thickeners, operated in series, according to the counter current decantation method. The purified and settled liquors, go to be used in the precipitation tanks, and the resulting mud to the sludge dump. Leaching of the "black ash" is thus almost automatic.

The barium sulphide liquors meet zinc sulphate solution, in a carefully controlled manner, in the proper proportions, with definite agitation, in large precipitating tanks. The conditions under which the precipitation is made have a very decided effect on the quality of the

finished product. Raising of quality standards from those thought to be good only a few years ago, has been the result of exhaustive study and development of the many variable entering into the operation.

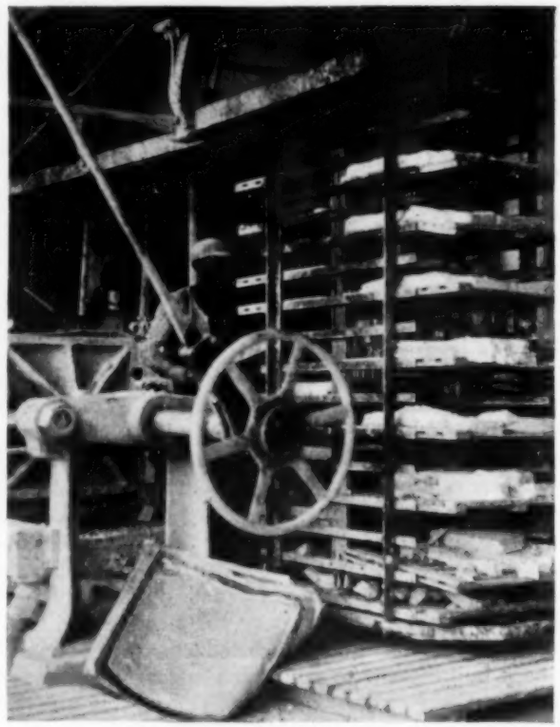
RAW LITHOPONE is washed and filtered in large plate and frame filter presses, which deliver the product in cakes. These are loaded on to shelves in racks suspended from an overhead monorail system by means of which the raw lithopone is conveyed to a continuous tunnel drier, warmed by air which had been heated by the waste gases from the black ash furnaces. The monorail system is continuous throughout the filtering room and the drier, allowing the racks to enter the drier wet at one end, passing through to be taken out dry at the exit. Only an exceedingly small amount of labor is consumed for moving material, and that is needed for supervision anyway. Heat conservation and the efficient use of thermal energy is shown by the connection of the barytes reduction and the drying of the raw lithopone.

In the course of its manufacture after drying in its raw state, lithopone must be calcined in order to make its properties of a type such as is desired. Calcination previously was done in furnaces, or rather muffle kilns, all of the operations being manual. Some of the old furnaces still exist at the plant, but they are bricked up and used for other work, to which they have been profitably adapted. Quenching of the lithopone after calcining was done by having the men rake out the material, and dump it into wooden boxes filled with water. Clouds of steam and dust were the inevitable companions of this method of processing. In the present method the entire equipment is automatic. Lithopone is ignited in revolving metallic drums, gas fired at the end opposite to that through which the lithopone enters.



Filtration of the Raw Lithopone
After precipitation of the lithopone, it is washed and filtered in large, rectangular plate and frame filter presses, of the manual closing type.

Temperature control at this stage of the manufacture is very important. Pyrometers with recording instruments attached to them, are much in evidence. The ignited lithopone passes to a quenching line where it meets water which serves the dual purpose of quenching and conveying a Dorr classifier. Here again we see the evidence of the metallurgical method of handling material continuously. The classifier makes two products. The course material goes to a pebble mill to be re-



Conveying of Filtered Lithopone
After filtration and washing, the filter presses are opened and the cakes loaded onto racks, carried on a monorail system and conveyed to the tunnel drier for removal of moisture preparatory to calcination.

ground. The discharge from the pebble mill joins the overflow from the classifier to be pumped up to hydro-separator. The hydro-separator overflow is minus 325 mesh, the water floated lithopone going to the settling and washing tanks. The underflow from the hydro-separator returns back into the circuit, feeding into the Dorr classifier.

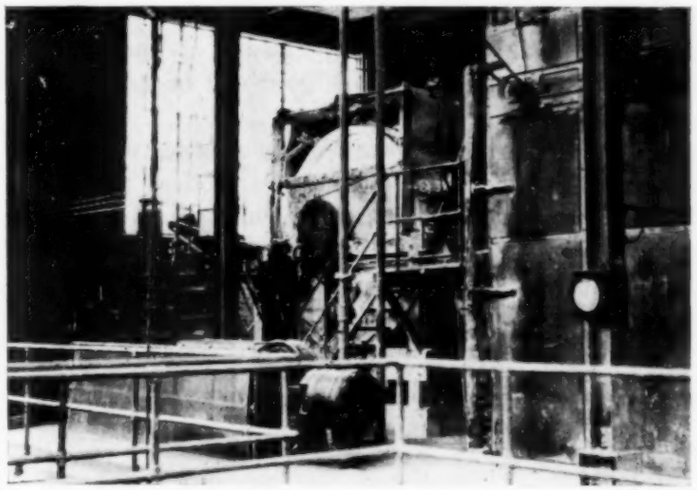
IMPROVED PROCESSES, as represented by the utilization of the most modern and newest of equipment in its various adaptations, is shown by the application of Charlotte colloid mills, used to disperse the lithopone in water solution and overcome the small amount of agglomerates. Inasmuch as the plant is making several products, different in grade, only part of the materials are processed in the colloid mills. The pulp from the washing tank is fed to an Oliver suction filter with a woven wire belt traveling around it, upon which the filtered lithopone is pressed. The belt continues to a drier of the festoon type, and is continuously dried and automatically removed from the belt after the drying period is finished. The belt returns uninterrupted to the filter, where it takes on a fresh load. This installation is a fine example of automatic drying and filtering. The equipment was furnished by Filtration Engineers, Inc. In the continuous method of filtration, employing suction filters, and continuous drives, only one man is needed to operate the two drying units, which handle the entire output of the plant.

Finished material from the drier discharges into bins, from which it is taken by a pneumatic system across a plant roadway, to a screw conveyor feeding Raymond mills, which pulverize the product. The almost entire absence of operators is conspicuous. The Raymond mills pulverize the product, the exhausters connected to the system delivering the air floated material to cyclones,

the collected material going to hoppers, and the exceedingly fine dust being collected in stocking type dust collectors. The finished material is packaged, weighed, and sacked automatically on continuous machines of the same type as are generally used for cement. Bulk storage is maintained at the rate of six weeks' supply in the basement of the finished product building. When desired, this material is reclaimed by means of a pneumatic system and delivered to the hoppers above the packing machine.

REPLACEMENT of the original wooden buildings with modern types of cement, brick, and concrete, has proceeded practically to completion. Elimination of the obsolete is known by the management to be a continued path to progress and profits.

Contrasted with these new buildings is the office of the president, A. S. Krebs. This is a substantial building of the old Colonial style, supposed to date from 1720, well known throughout Delaware as the birth place of Oliver Evans, one of our earliest American inventors and often called the Watt of America. He is stated to have been the inventor of the slide valve steam engine, the bucket elevator, and the screw and belt conveyor. The building is built of bricks which were brought over as ballast in sailing vessels from Sweden.



Drying of Ignited and Quenched Pigment

The pigment is filtered on a suction filter, taken up on a wire screen, carried in a continuous manner through a festoon drier and delivered at the exit end of the machine. Two such units handle the entire output of the plant.

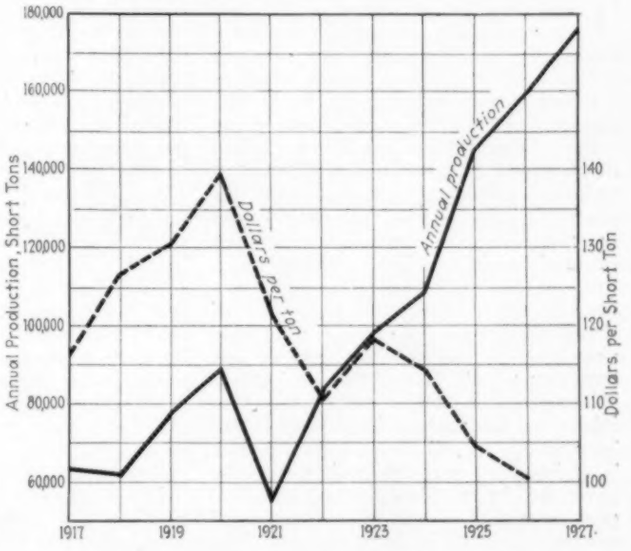
The over-all cleanliness of the plant is a delight to the engineer who far too often has been led to associate grime, dirt, and disagreeable conditions with the chemical process industries. In the eyes of the management, as a result of its progressive nature, it is thought that modernization of the past can, and will continue at a little slackened rate, until it is brought to the highest point possible. This attitude effects not only the mechanical and equipment side of the plant, but also the technical and research end of the business. Certain it is that spending money to save money has brought the company an enviable reputation for high quality which has greatly increased the demand for lithopone.

This article has but touched the high points of a plant in which the constant drive is for the elimination of labor, with replacement of batch processes with continuous ones, a reduction in cost of operation, and constant improvement in processing and products.

It is quite fitting that the head of this organization should have his office in the birthplace of one of America's foremost inventors, Oliver Evans, for his memory is a constant reminder of progress and improvement to mechanical applications. Perhaps his spirit still abides somewhere near his birthplace.

THERE ARE SEVERAL features in the power house in connection with supplying steam for heating and processing. Power house equipment consists of turbo-generators operating under a back pressure of one to two lb., the steam being used for heating. Steam is generated at 175 lb. pressure and superheated. That used for process steam is reduced to lower pressures by the use of reducing valves. This makes for more efficient steam generation. There is still need for more power at the plant other than what is generated there in the power house of the plant. As a result, connection is made with an outside source of power. Provision was made for a continuous 24-hour load. An ingenious device has been set up in order to constantly keep this outside load at the same figure, and vary the turbine load in the plant. Reversible motors have been connected up to the valves on the turbine. The speed and direction of these motors are controlled by wattmeters, seemingly operated backwards. In other words, the power input from the outside source, that is the city line, controls the output of the turbines of the plant. In this manner the current consumed from the outside is kept constant, but the turbine load at the plant is made the varying load to satisfy the surges and changes in demand in the plant. It is believed that this installation is the first and only one of its kind.

The economic effect of modernization on the lithopone industry is readily seen in the graph below. Better and increased quality and uniformity has expanded the applications of the pigment. These have demanded increased production. The increased production in modernized plants has resulted in lower production costs and lowered prices to the consumers. Since 1923 the production curve has been rapidly rising, while the price curve is on a downward trend of a very decided nature.



What Modernization Has Done for the Lithopone Industry in the United States

MODERNIZATION *vs.* OBSOLESCENCE

YEARS do not make obsolescence. Neither in chemical engineering plants nor any where else in industry is the age of equipment necessarily a measure of its modernity. Unlike its cost accounting twin, depreciation,—with which it is so often confused—obsolescence cannot easily be evaluated according to accepted principles. Certainly mechanical condition is no index. Creaking age, high maintenance may be years ahead, and yet the equipment become suddenly a liability and a penalty upon efficient production. Modernization is a mailed fist which frequently carries the threat of sudden change and revolutionary development.

What would be shown by a searching study of the actual effectiveness of the process equipment within your plant? The Department of Commerce estimates that fully a third of the factory capacity in the United States is represented by obsolete machinery that could profitably be replaced by modern equipment. Actually it is being replaced, if not in your plant, in the plant of your more progressive competitor.

All obsolescence is not bound up in physical equipment. There are attitudes of mind which are as surely ready for the scrap heap. Not the least disturbing of these is the fetish of secrecy which still prevails in many process industries. Fear of losing a temporary advantage by sharing a new development with a competitor soon leads to indifference and inability to face the reality of process improvement. The "hush-hush" enthusiast forgets that the disclosure of knowledge is reciprocal and that his gain will be no less than that of his competitor.

In the pages which follow an attempt has been made to point the trends of modern practice in several chemical fields. While the survey is incomplete, the tendencies revealed are suggestive of methods, of equipment, of processes that cannot be measured in pages but rather in their applicability throughout the process industries.

Lime Industry Adopts Modern Attitude In Solving Its Technical Problems

By G. J. Fink

Director of Research, National Aluminate Corporation, Chicago, Ill., and Formerly Chemical Director, National Lime Association

THE MARK of progress in the modernization of lime manufacture during the past two or three years is not so much the actual improvement in equipment and process as it is the change in attitude of manufacturers and technical men. There has been a marked development of investigative interest in technical problems confronting the industry. This interest has only begun to crystallize into actual results but those plants in which it is finding practical application are outstandingly successful, even during the past year of shrinking profits. As proof, it is only necessary to mention the case of one company which during this period has sold the entire output of a new plant into a territory where heretofore it had been unable to sell as much as a pound. This has been accomplished, it must be appended, by combining sound technical equipment and operation with technical salesmanship and business sagacity. The result proves that the lime business is no different from any other business.

Quarrying practice and kiln type and design, with special reference to the particular manufacturer's individual problems, have lately received much consideration and some more or less radical departures from previous practice have been made. In case of rotaries, lengths are being increased markedly; 175-ft. kilns with daily capacities of 175 tons are not unusual now while with shaft kilns it has been demonstrated that larger size and increased capacity are entirely feasible. One company has recently put into operation a gas-fired shaft kiln which continually produces 50 to 55 tons of excellent lime and has a maximum capacity of 65 tons. Exceptionally small diameter shafts have also been built for preferential burning of components of mixed carbonates with rather promising results.

Much progress has been made on the problem of burning limestone fines and it appears that this may soon be practicable. In calcining greatest interest, perhaps, has centered on the problem of kiln efficiencies, with the work of Azbe and of Haslam outstanding (See *Proc. Natl. Lime Assn.* 1926). This has involved improvements in design of fire boxes, stokers and gas burners, in firing and drawing practice, in type of refractories and in sizing of stone as well as in modifications of kiln design. The previously common sight of large volumes of smoke issuing from coal-fired kilns has been eliminated at certain plants and efficiencies as high as 1 pound of lime per 3110 B.t.u. input have been recorded, as compared to a low return of 1 pound per 5450 B.t.u. recorded at another plant. Thorough investigations of the effect of steam in kilns have been made and means of reducing this fuel requirement have been pointed out.

Greater differentiation and selection of stone types have also resulted in greater uniformity in operation and better quality in burned product. Some progress has been made in modifying kiln conditions by additions of foreign materials to the stone charge, Briscoe and Mathers [*Ind. Eng. Chem.*, vol. 19 p. 88 (1927)] for example, having shown that the addition of alkali chlorides to the stone so modifies the properties of the resulting lime as greatly to alter its rate of slaking and to improve considerably the plasticity of the hydrate.

Probably the greatest real advance has been made by the development, introduction and promotion of pulverized quick lime. This is a ground lime of such fineness that it can be slaked and used immediately for plaster and mortar without danger of unsoundness. It yields a putty of a plasticity, workability and sand-carrying capacity comparing favorably with the best-aged lump lime putty. In the chemical field it has the advantages of high purity and available lime content (94-98 per cent available CaO), direct dry feeding without intermediate slaking or danger of drowning or choking the feed, and, of course, low freight charges. These properties together with the successful marketing in waterproofed paper bags make this product a serious competitor of hydrated lime in both chemical and construction fields.

Intensive and extensive experimental effort with much laudable progress and actual accomplishment has been made in hydration. Results forced the delayed conclusion that none of the previously available commercial hydrators approached the ideal either in mode of operation or results and practically every progressive plant has made modifications in older installations and operations or have discarded these entirely for their own modernized processes. In general the tendency has been toward finer grinding of the lime to be slaked, preliminary and more thorough mixing with slaking water, stricter control of quantity and quality of water and more careful regulation of local hydrator temperatures. Adams has demonstrated the effect of particle size of the quicklime on the quality of resulting hydrate (see *Ind. Eng. Chem.* vol. 19, page 589 (1927), and others have shown the effects of additions to slaking water, temperature variations, etc. Much effort has been expended on the problem of plasticity both as to its causes and its production. Although there is now some question as to the real economic necessity or even desirability for a plastic high calcium hydrate, decided progress has nevertheless been made toward this accomplishment.

LIME MAKERS are tending to a diversification of outlets and of products and the industry is thus being better stabilized to meet business depressions which affect only certain sales channels. In addition to pulverized quicklime various grades of pulverized stone and precipitated carbonate are being produced and the present depression is forcing the development of outlets for special grades of both quicklime and hydrate which have never before been considered. Lime is being *sold* rather than simply delivered on order. Foreign practices both as to technical operation and business organization and procedure are being studied and it is expected that many of these details can be adapted to local conditions with profit.

On the whole, there is no question but that real progress has been and is being made. In spite of the fact that cooperation within the industry for the accomplishment of these ends has temporarily failed, the industry is profiting from a newly aroused interest in its problems on the part of engineers and chemists outside of its own household and from accumulated facts and data within the industry which have been growing rapidly in volume during the past few years.

Petroleum Refiners Replace Obsolete Processes with Efficient Modern Equipment

By J. C. Morrell

Universal Oil Products Company, Riverside, Illinois

MODERNIZATION of petroleum refining implies not only the installation of new equipment for increasing efficiency and decreasing cost, but also the general adoption of improved older devices, such as the pipe still, and of specialized equipment borrowed from other industries, such as the bubble tower fractionating column.

During the past five years the pipe still has displaced the shell still to a large extent for crude oil distillation. The chief reason for this change has been greater all-around efficiency, such as smaller fuel consumption and larger capacity for the same investment. The greatest single factor in this advance is improved heat transfer. Whereas several years ago a heat transfer rate of 5,000 B.t.u. per sq.ft. per hour was considered good, today it is not uncommon to obtain a rate in oil still operation of from 25,000 to 35,000 B.t.u. per sq.ft. per hour. The general adoption of the principles of radiant heat in furnace design and a careful study of oil velocity factors, together with flue gas recirculation, have been responsible for this improvement.

ECONOMY in fuel consumption has been effected by improvements in the design of heat exchangers, and today a liberal distribution of heat exchangers over the refinery is considered a necessity. There have likewise been improvements in the design of condensers, which have effected a saving by reducing the loss of the volatile components of light distillates with consequent increased recovery. Fuel saving has also been effected by increasing the capacity of the units, not only through improvements such as those cited, but by increasing the size of the units, thus reducing the ratio of radiation surface to total volume.

Pipe stills of 5,000 barrels per day capacity are at present common. The displacement of the shell still battery by the pipe still has taken place parallel with the installation of improved automatic temperature control equipment, constant level and other devices which have likewise been a factor in improved operation.

Some improvements in cylindrical or shell stills have been made by increasing the heat transfer by circulating the oil and rapidly discharging the streams over the bottom sheets of the still. The consumption of fuel and steam has been reduced, but it appears that such improvements are advantageous only in connection with the partial modernization of old equipment.

Fractionating Columns.—During the past five years the refining industry has generally adopted efficient fractionating columns. The old columns used for fractionation consisted usually of perforated plates, or where packed columns were used the refiner selected the packing to suit his fancy, for example, cobble stones, bricks, flower pots, jardinieres, and even tin cans. Today the packed column consists of properly sized and selected packing disposed in sections on grids to avoid channeling. Special packing such as Raschig and spiral rings have been adopted.

The bubble tower, which was uncommon in the petroleum industry a decade ago, has now been universally adopted both for crude oil batteries and rerun stills. Improvements in bubble tower design have been directed mainly toward increasing the efficiency of contact between the ascending vapors and descending liquid. Plate efficiencies of 80 per cent are obtained in a few installations. A careful study of velocity factors and proper distribution of the liquid upon the decks, as by the use of baffles, cap submergence and cap distribution, have also been helpful. A great deal of work has been done with various shapes of caps to permit a better arrangement of them upon the decks, but whether improved results have always been obtained is doubtful.

Automatic temperature control instruments permitting exact control of the volume of reflux and of the temperature in the top of the column has facilitated the production of any desired cut without sacrificing efficiency of fractionation.

Lubricating Oils.—The greatest improvements in lubricating oil manufacture during the past five years have been in the contact filtration process, the adoption of the pipe still for lubricating oil manufacture, including the single flash bubble tower system, and the use of low pressures or high vacuum. The use of more efficient furnaces of the Herreschoff and Wedge types for reburning clay has, however, given the percolating system a new lease on life.

The use of vacuum and the combination of vacuum and steam are old, but remarkable results have been obtained at very low pressures—for example, less than 3 mm.—the yield being increased and treating costs reduced. Gulf Coast oil refiners now generally use a combination of steam and vacuum.

Marked improvements have been made in the dewaxing of petroleum oils for the production of lubricating oils by centrifugal methods, and these are

now replacing cold settling plants in the manufacture of bright stock. Today the centrifuge is also being used for the dewaxing of long residua and overhead distillates: the yield of petrolatum is reduced, thus increasing the yield of bright stock. More complete separation of the wax not only increases the yield of this component, but also reduces the cold test of the oil. In some installations a closely fractionated wax distillate cut is taken from a tower that does not need recracking.

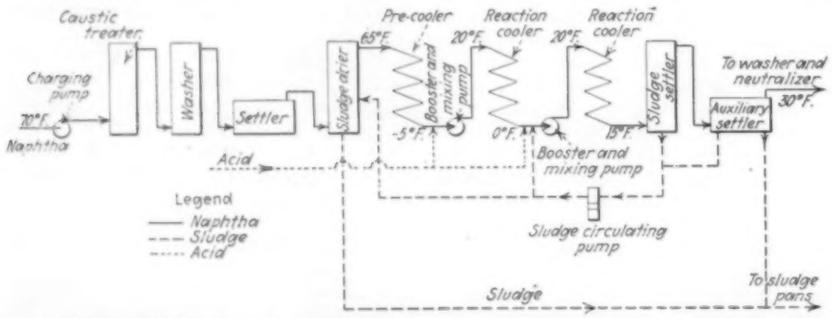
Refining of Distillates.—The major improvement in equipment for the treatment of distillates has been in the displacement of the batch agitators by semi-continuous and continuous treating systems. Practically all new installations are of the continuous type, which are simple and automatic in control, and which reduce the over-all cost of treating by reducing the evaporation losses and labor costs. Efficient mixing devices have reduced acid consumption.

The major improvements in the modernization of cracking equipment have been improved furnace design, including flue gas recirculating systems, hot oil recirculating pumps for reflux, and the flashing system.

Parallel to these fundamental improvements have been the installation of automatic pressure and temperature controls, improved heat exchangers, and condensers. The use of radiant heat together with flue gas recirculation has constituted a distinct advance in furnace design. The capacities of cracking equipment have also been increased with consequent improved fuel efficiency.

Vapor-phase cracking is receiving renewed attention after a lapse of many years. This type of cracking may be referred to as high temperature cracking—for example, where the oil is vaporized and heated usually in excess of 1,000 deg. F.

The chief drawbacks to vapor-phase cracking are the large gas losses, high fuel consumption, the greater difficulty in refining the motor fuel, low throughputs and short running periods, and deterioration of the equipment caused by the high temperatures used. There is also a limitation in choice of charging stocks, which can be cracked directly by vapor-phase methods.



Applying Refrigeration to Continuous Treatment of Pressure Distillates by the Halloran Process

This process, first described before the American Petroleum Institute at Chicago in December, 1927, is commercially applied by the Standard Oil Company of California. The acid required for treatment has been reduced over 40 per cent; the treating and polymerization losses are lower by 30 per cent and 60 per cent, respectively.

Vapor-phase refining for cracked distillates has been used to some extent. In this form of refining as developed by T. T. Gray, the raw oil is distilled through a column of fullers earth. The process has produced remarkable results with some types of distillates, but with other types it can not be economically applied. In some cases it is combined with sulphuric acid treatment—that is, the distillate is given a light acid treat and redistilled through the fullers earth.

MOST outstanding improvement in desulphurization, in the writer's opinion, has been the cold treatment with sulphuric acid. A continuous treating system is adopted for this purpose, the oil being refrigerated and contacted with the sulphuric acid in steps. This process is especially applicable to the treatment of distillates of high sulphur content; in the case of cracked distillates it is more effective than treatment with sulphuric acid at ordinary temperatures and in addition reduces losses.

Cracking. — Tremendous advances have been made in the yields of gasoline obtained by cracking. Five years ago a yield of 35 per cent was considered good, whereas today yields of 75 to 80 per cent from the cracking of gas oil and 50 to 75 per cent from the cracking of fuel oils are not uncommon.

Some of the advantages of the vapor-phase process are the high anti-knock properties of the motor fuel and the relatively low operating pressures, permitting the installation of lighter and less expensive equipment.

In all probability, the vapor-phase process will be used as an auxiliary method for producing a blending-stock to improve the anti-knock properties of the motor fuel with which it is blended, although we have gone far in this respect with cracked gasolines from the liquid-phase cracking processes.

The gas from cracking should be of particular interest to the gas industry. With the liquid phase cracking process —for example, cracking heavy oils to coke and distillate—as much as 800 cu.ft. of gas per bbl. of oil will be produced, and the vapor-phase processes will start approximately at this quantity and go to any point one desires, even to practically complete gasification.

It is believed that vapor-phase cracking will play an important part in the production of chemical derivatives from petroleum—for example, the production of solvents, antifreeze agents, and explosives from ethylene, synthetic rubber from butadiene, resins and lacquers from the polymerized and partially oxidized unsaturated components, and it also opens up the field for the manufacture of the present coal tar derivatives.

Corrosion.—Marked advances have been made in the protection against corrosion during the past five years, especially of refinery equipment. Corrosion of pipe lines has received more careful attention over a much longer period, but a study of corrosion of refinery equipment has been most intense during the past several years.

Some of the metallurgical methods which have been suggested for controlling corrosion are as follows:

1. The manufacture of pressure-still equipment from highly resistant alloys such as the chrome irons or chrome steels.
2. Electro-plating with such metals as chromium.
3. Lining reaction chambers with chrome iron, aluminum, or other corrosion-resisting metal or alloy.
4. Coating the surfaces with a corrosion-resisting metal or alloy by means of welding appliances.
5. Coating the walls of the chamber and dephlegmator with corrosion-resisting elements or alloys by means of spray-guns.
6. Using Calorized steel surfaces.
7. Lining reaction chambers and dephlegmators with plates of mild steel and replacing them as they corrode.

In addition, basic chemical materials such as caustic soda, lime, ammonia, and mixtures of these have been injected into the high temperature elements to overcome at least in part hydrogen-sulphide corrosion. Similar reagents have been used in the colder parts of the system to overcome hydrochloric-acid corrosion.

One of the most outstanding developments during the past few years in protection against corrosion has been that of non-metallic protective linings about which additional information will shortly be available.

Graphite Articles Improved by Automatic Machines

GRAPHITE manufacturers have recently installed automatic machines for threading the ends of electric furnace electrodes and the nipples which are used in them. The joint in an electrode has always been its weakest link. These automatic machines, adapted from the machine tool industry, do away with the chance of error through entrance of the human equation into the manufacture of joints, with the result that perfect uniformity is now obtained. Nipples of higher tensile strength have been developed by a study of binders and the many variables entering into manufacture. Nipples are now made with greater tensile strength than the electrodes themselves. Costs of graphite have been reduced so that instead of being 3 to 3½ times as much as amorphous carbon, they are now only from 2 to 2½ times as much.

Technical Control, Modern Equipment and Methods Help Modernize Gelatine Manufacture

By Joseph H. Cohen
Treasurer and General Manager
Atlantic Gelatine Company
Woburn, Mass.

WE SPEAK of modernization today much as it was spoken of in every preceding era. The fundamental urge to advancement in industry is the ever increasing demand, by the public at large, for better materials with respect to appearance and utility. The public has gained an appreciation of the value of technical control as applied to manufactured products and thus the modern appeal to consumers on this basis has borne surprisingly good results. The gelatine manufacturer of today makes use of every expedient devised by science and in this respect keeps abreast of progressive industrial development.

First of all we have learned much about the chemical composition and physical behavior of gelatine; in addition, a large amount of investigational work has been done on the food value of gelatine and on its behavior when compounded with other foods. As a result of many favorable reactions of gelatine on the human economy and its recognized value as an addition to some important manufactured food products, gelatine consumption has increased largely during the past few years.

Refinement of gelatine is due chiefly to technical control in manufacture, to the employment of skilled labor, and modern equipment. The refrigeration unit of the modern gelatine plant insures uniformity of working conditions at all seasons of the year. The product is guarded against contamination at every step of the manufacture. Pure water, pure air, sterile equipment, are all important factors in modernization of gelatine manufacture.

The raw material used for gelatine extraction is of a higher order than ever before. Some classes of material are shipped direct to the gelatine plant in refrigerator cars. Other classes of material are scientifically prepared in milk of lime. Each method has its special advantage. Each is carried out with the utmost care.

Many of the larger producers of foods, containing gelatine, have installed equipment for testing the physical and chemical properties of the gelatine they purchase. This promotes helpful cooperation between the maker and user. As a result there has arisen a form of service on the part of the gelatine manufacturer which is entirely independent of sales promotion although greatly contributing to it. This service includes investigations into methods, formulas and problems in which the consumer is interested. Actually, the gelatine manufacturer is equipped to make almost any product employing gelatine and in many cases improve upon a form of production in use by the food manufacturer. In this way many problems have been solved and the general public better served.

In short, science, skilled workers, technical control, modern equipment and public appreciation, each contribute their full share to the steady progress in modernizing the methods of gelatine manufacture.

Factors in Modernizing a Process Industry

By Ernest Owen
Brooklyn, New York

FIVE factors that have proved important in modernizing a large petroleum refinery, and that are equally applicable in many other of the process industries consist of the following:

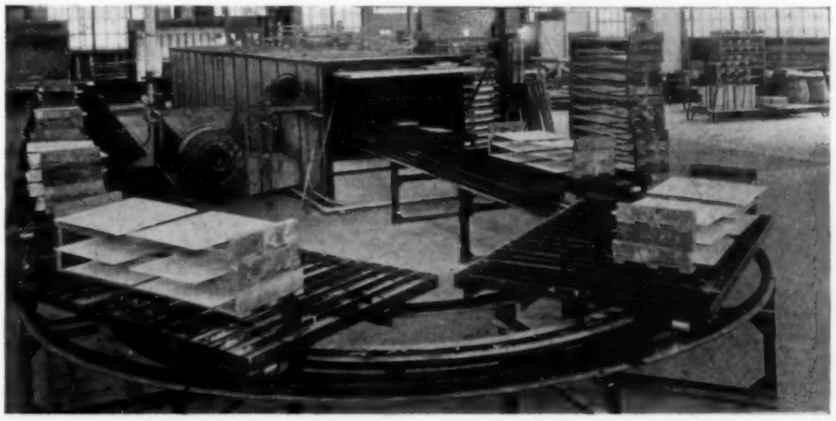
(1) Close grouping of related units and operation. This has involved the concentration of the mechanical shops in one section of the plant, the replacement of a number of scattered boiler houses and power units by one centralized power plant, generating high pressure steam, the reduction in the number of pump houses, etc.

(2) Gradual rearrangement of process units so that as far as practicable there will be an uninterrupted flow of raw materials to finished products.

(3) More extensive use of automatic control and recording apparatus (temperature, pressure, rate of flow, liquid level, etc.) and their centralization in the control house of each unit.

(4) Standardization and simplification of structural and mechanical equipment. For instance, where formerly an oil refinery might have pumps installed which were made by a dozen or more different manufacturers, the present tendency is for each refiner to standardize on one or possibly two manfacturers of pumps. This is advantageous from both an operating and maintenance standpoint, reducing the number of spare parts necessary to carry in the storehouse stock.

(5) More economical utilization of heat in its generation, also in application and recovery. This has involved improvements in furnace design and combustion, the application of the principles of radiant heat to furnace design; use of air preheaters, flue gas economizers and flue gas recirculating systems.



Continuous Drier Showing Ware Being Conveyed to Firing Oven

Continuous Driers Improve Metal Enameling

TENDENCIES in modern drying practice point unmistakably toward the elimination of batch drying operations wherever possible. An interesting example of continuous driers is found in the plant of the Louisville Enameled Products Company at Louisville, Ky., where two driers are employed in processing enameled ware prior to firing.

The plant includes equipment for the preparation of the coating materials, for the sand blasting and pickling of the ware, for spraying and dipping, for drying and finally for firing the enamel finish in electrically heated furnaces. The two oven driers are of the "Hurricane" type, built by the Philadelphia Drying Machinery Company. They consist of 40-ft. tunnels through which run continuous, circular, power driven conveyors on which the ware is carried through the driers at a speed depending upon the requirements of the material going through.

Air is heated by steam, controlled by temperature regulators, to a temperature of 190 deg. F. and is blown through the driers at the rate of 3,000 cu.ft. per min. This maintains a drier temperature of 170 deg. and permits uniform drying, regardless of weather conditions. Dried ware is removed from the conveyors at a point adjacent to the furnace where it is loaded directly upon the empty half of the double charging fork.

This drying operation is frequently still carried out in batch driers. Continuous operation has eliminated much labor in rehandling, has permitted close control of drying independent of weather conditions, has reduced losses and blemishes and has lessened manufacturing costs and speeded up production.

The Unusual Setting of the Tennessee Mineral Products Company at Spruce Pine, N. C.

Chemical Control and Modern Grinding Methods Stimulate Feldspar Industry

By F. P. Knight, Jr.

Chief Chemist, Tennessee Mineral Products Company
Spruce Pine, N. C.

ANNUAL consumption of feldspar in the United States is about 200,000 tons. Its consumers include the manufacturers of dishes, sanitary and electrical porcelain, enamelware, abrasives, terra cotta, glazed brick, glass cleansers, and kindred articles. Practically the entire tonnage is sold in powdered form. Improvements in mining and grinding the crude rock have been numerous during the past ten years. Feldspar itself is an extremely variable product as mined. Such variation has been a continued source of annoyance and loss to the industry. Chemical control was undertaken by the Tennessee Mineral Products Company in 1924, and its new plant at Spruce Pine, North Carolina, contains other features which point toward a modernization of the industry.

Milling of feldspar is a simple grinding problem if the control feature is disregarded. Under the old régime, feldspar was sorted at the mines. Sorting of the run-of-mine material is a very important feature, as iron-bearing impurities must be carefully eliminated. In this process the rock was broken by hand to pieces mostly of less than 6 inches diameter. The sorted product was hauled to the mills and fed to "chaser mills," pieces larger than 4 inches in diameter being first broken by hand. These chasers are still in use. They resemble a Chilean mill: two granite disks of about 5-ft. diameter with 14-in. face, rest on a stone base and roll on horizontal axes, which are fixed to a central, rotating shaft. No pan is used as is the case with Chilean mills. The discharge from the chasers passed to $\frac{3}{16}$-in. or $\frac{1}{4}$-in. trommel screens, and oversize was returned to the mills. The chaser products were fed to cylindrical batch mills 5 ft. to 6 ft. in diameter, and 6 to 8 ft. long. These mills were lined with silex brick, and flint pebbles were the grinding medium. A charge of feldspar for such a mill was about two tons. Each batch was ground about six hours and then dumped, a screen on the mill door holding back the pebbles. The resultant product was loaded for shipment.

These older methods are still in use, but the modern method includes a jaw crusher feeding to Hardinge mills in closed circuit with air separators. The reduction in kw.-hr. per ton over the old method is about 33 per cent, and the increase in capacity per mill is in the neighborhood of 500 per cent. An initial disadvantage of the continuous process was the distinctly coarser average particle size it yielded, and this difference affected the fusibility of the material. Lower cost and finer air separator adjustment tended to offset this difficulty and the introduction of a tube mill into the Hardinge-air separator circuit gave increased capacity commensurate with power input, and a finer average particle size. Several different "hook-ups" are employed, and the recent installations of Hardinge unit pulverizers have improved plant conditions, although their economy is not yet fully established.

Sorting the Run-of-mine Feldspar on the "Picking Belt"

Methods of control of its products offer the greatest opportunity for modernizing the feldspar industry. It must be appreciated that feldspar is a term applied to a group of minerals, all of them aluminum silicates with either potassium, sodium, calcium, or barium. Selected crystals always contain the first three of these in varying proportions. A crystal in one part of a pegmatite is different from that in another. Feldspar high in soda may be adjacent to crystals high in potash. Quartz is irregularly scattered throughout a deposit. It is easy to see that no two truck loads could be identical even after sorting. Consumer's demands are also extremely variable, and, therefore, the problem of correlating the two variables demanded study.

THE Tennessee Mineral Products Company in 1923 operated under old methods of control. It attempted to supply only a carefully selected, high-grade material. Fired trials were the only tests employed to regulate variation of mineral content. Large stocks of crude rock were maintained in order that an average could be drawn which would come within required limits. Realizing that growth and profit demanded ability to meet varied specifications, a laboratory was equipped for analyzing crude rock, and all shipments of finished product. Accuracy was demanded and no results were reported until all methods of procedure were tried, weighed, and discarded or adopted. The work was put on routine basis and four days allowed for each analysis. The analyses proved to be very valuable, but sampling of crude material remained a difficult problem. Meanwhile, diverse specifications were coming from consumers. They were met with greater accuracy than before control was applied in the industry, and business increased until the erection of a new plant with adequate control facilities was warranted.

Then, at considerable expense, processes were adopted that represented an entirely new departure from existing practice. The improved process is shown

in the accompanying flow sheet. Its principal features are:

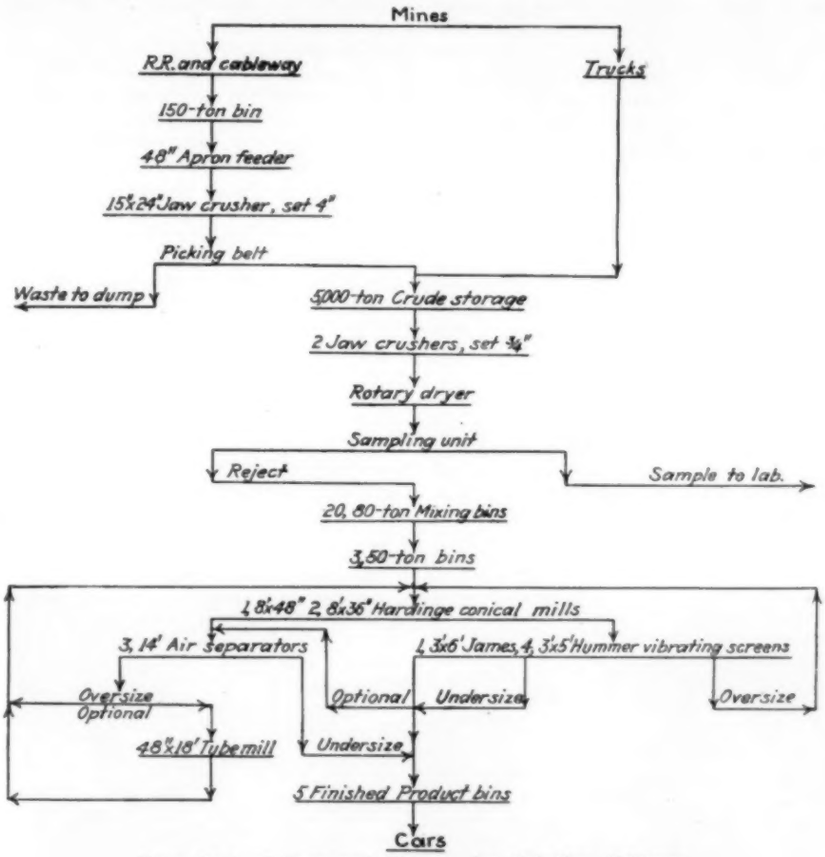
1. A sorting belt to handle run-of-mine material and permit selection of various grades at low cost.

2. A sampling unit—entirely automatic and functioning according to best principles of sampling. The company designed its own automatic samplers to handle the minus ¾ in. crusher product, and the sample after intermediate crushing, without iron contamination. A 2½ per cent cut is taken from the sample. Accuracy is definitely established.

3. Twenty mixing bins of 80 tons capacity each were added. The contents of these bins are accurately known through tests of the samples taken while filling them. The widely varying analyses permit blending to meet any logical specifications.

4. A Ruggles-Cole drier proved a distinct aid to grinding costs as well as a large factor in close adherence to mesh specifications.

The superiority of chemical control and modern operating practice has been fully demonstrated. There are many other problems still confronting the feldspar industry, but improvements are in the offing, and with the intense competition spurring producers, continued advance in production and control methods is inevitable.



Flow-sheet of Improved Process for Grinding Feldspar

Improving Distillation in Petroleum Refining

Five years ago the average efficiency of a petroleum still was not much over 30 per cent.

During exactly the same period the show an efficiency of 75 per cent. Due to improvements in equipment, the amount of re-running has been reduced nearly one-half. By keeping up-to-date with processes and equipment one 50,000-bbl. refinery has, within but two years, reduced the cost of distilling crude oil in shell stills from $0.1243 to $0.0876 per bbl.—a reduction of nearly 30 per cent.

During exactly the same period the cost of distilling crude oil in pipe stills was reduced from $0.0722 to $0.0557 per bbl.—a reduction of almost 23 per cent. These advances were due entirely to modern equipment.

Cement Mill Modernization Demands Larger Units

EXCEPT in unusual cases, modern practice in cement mill construction has been met only with wet process plants. This change has converted a one time dirty and dusty industry into one where the visitor no longer needs a suit of over-alls. Capacities of individual pieces of equipment have increased enormously from the early grinding units of fifteen barrels per hour to those of the present day of one hundred and fifty barrels or more. All raw grinding is wet. Slurries replace dusts prior to kiln treatment. Mixing tanks for slurry have greatly increased in size. Power studies on agitation equipment have caused marked reduction in power costs as the result of the introduction of modern stirring devices. On the clinker grinding end, pneumatic conveying equipment and dust handling machinery are now the only acceptable standard. Along with greater economies, wet processing has markedly increased the uniformity and quality of the cement.

It is sometimes maintained since most of the existing dry process plants in the United States are old and do not possess the most modern equipment, that a comparison between the two processes usually resolves itself into a comparison between old dry plants and new wet plants. It is claimed that the new plants make better cement primarily because they are new, not because they are wet. Van Zandt of the Colorado Portland Cement Company at Denver, Colo., states that the Boettcher plant of this company is the most modern dry process plant to date, designed to produce a cement of the highest possible quality and of absolute uniformity which cannot be exceeded by any wet process. Water is scarce and costly and is badly needed for irrigation in the fertile Poudred River Valley farmland. It is believed that this was the governing factor in deciding whether the plant should be erected as a dry process or a wet process unit although admittedly a uniform quality is obtained.

General View of Tennessee Mineral Products Company
The fine grinding building is seen at left, the mixing bins are in the center and the sorting belt and crude storage facilities are at the rght.

Coke-Oven Practice Contributes Improvements in Coal-Gas Production

COAL GAS is now recognized as the necessary base-load supply for practically all city gas. Hence it has been necessary to develop the maximum flexibility in output of coal-gas plants in order to meet as economically as possible the changing load requirements of a city. The optional use of either oven gas or producer gas for heating the battery of ovens is one of the important developments assisting to this end. The Koppers-Becker type oven, as one of the first exponents of this type of heating, has been correspondingly popular among gas companies. To some extent other ovens have undertaken to use this same idea of the combination heating system.

MOST improvements in coal-gas production equipment have been in the field of coke ovens and their accessories. The single charging-hole system developed by the engineers of the New England Fuel and Transportation Company is one example of such an improvement that has been widely and favorably noticed. There has also been a tendency to apply for small-capacity ovens and plants with very few ovens all of the principles which have been developed primarily for the big coke-oven plant. As a result there have been built plants which are strictly speaking coke ovens, but which handle as little as 25 or 30 tons of coal per day. In such small plants the entire battery capacity is barely equal to the capacity of a single oven of the type used in the large coke plants. The use of ovens rather than retorts for such small plants has been justified because of the superior quality of coke and of the much lower labor cost. The saving in labor cost alone in many plants more than justifies the somewhat greater investment in carbonizing equipment.

Among the interesting developments in coke-plant accessories has been the dry quenching process developed by two different companies in the United States. This cooling of coke with recovery of the waste heat in the form of steam has proved a distinct success under certain circumstances, and considerable promise appears to be ahead for this type of waste-heat recovery. The recovery of waste heat in coke plants is, however, not yet as widely practiced as in water-gas plants where the use of the waste-heat boilers on the stack gases serves to recover practically enough heat to supply the plant steam requirement.

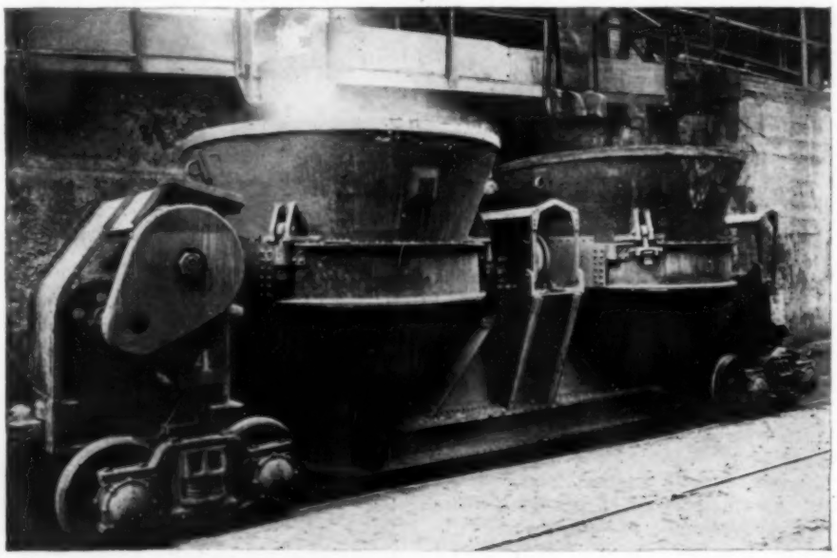
In the field of byproduct recovery at coke works the necessity for making ammonium sulphate instead of ammonia liquor has occasioned careful attention to the direct-sulphate processes. Many plants of such size that a direct-sulphate plant would not have been considered ten years or more ago are now installing this equipment, because they find very little market for liquor and thus in order to dispose of the ammonia must make ammonium sulphate. The joint production of sulphate by a group of plants geographically near each other is also being worked out in some areas. In such cases the largest plant will install a direct-sulphate plant and will work up the liquor from its neighbors by the indirect process. Such a combination is probably in most cases more economical for small works than the installation of separate sulphate plants in each of the works.

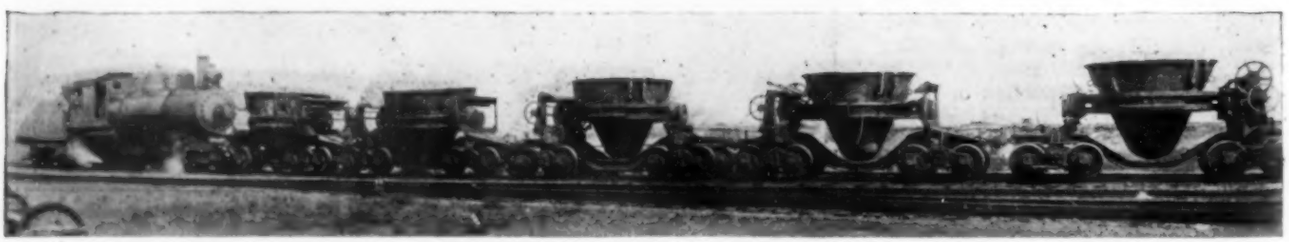
In the manufacture of sulphate there has been a distinct trend toward the production of dry acid-free white salt. This has been necessary in order to get the more favorable prices for the output of coke works. The result has been accomplished both by better designed plant equipment and more careful plant operation. In some cases, however, gas or coke works have gone so far as to put in sulphate driers of the rotary kiln type in order that a water-free salt could be guaranteed at all times. The substitution of ammonia oxidation for Chilean nitrate has come about very rapidly. This development has afforded a new potential market for ammonia which is of considerable magnitude, including both the makers of sulphuric acid and the makers of nitric acid.

Water-Gas Manufacture Made Automatic

WATER-GAS manufacturing has been made completely automatic within the last few years. There have been developed a variety of operating mechanisms which carry out the cycle of operations during the period of blast, purge, gas-making and even the special back-run, blow-run, and down-run variations. Still more recently there have been several automatic stoking and automatic ash-discharge devices developed which make it practically unnecessary to open the water-gas machine except at long intervals. Very great increases in output per machine per day have resulted, with corresponding reduction in capital charges and labor.

Among the modified cycles for water-gas making are several variations of the back-run, which was the first of the group. Among the improved possibilities of gas-making resulting from these new cycles, perhaps the most interesting possibility is that of making water gas of low specific gravity, which would greatly aid in mixed gas supply.





The Two Modern Slag Pots (at top) Have Replaced a Trainload of Five Obsolete Pots of Smaller Capacity

Greater Strength and Improved Appearance as Rayon Approaches Maturity

RAYON has in the last few years lifted itself by its own bootstraps from a position of shame-faced imitation to an eminence where it now competes with silk on its own merits—not as a substitute but as a new and extremely popular textile fiber.

It was recognized several years ago that technical excellence, because of the relatively large investment demanded of the rayon producer, must wait to some extent upon increased consumption. The stigma of imitation and artificiality under which it labored was evidently one of the chief drawbacks to popular demand. Change of name from "artificial silk" to "rayon" plus a well conceived campaign of consumer education made possible the intensive research programs of the last few years which are now surely bearing fruit today.

Modernization of rayon has progressed in a number of directions with the several ideas of lowering costs, increasing strength and improving appearance. The program has been most striking in the case of viscose rayon which accounts for 80 to 90 per cent of world production. Mechanical improvements have speeded up production and reduced attendance. For example virtual abandonment of the bobbin spinning machine and the substitution of pot spinning for all but the very fine and very heavy deniers have eliminated all or a part of the twisting required to hold together the individual filaments of pot-spun rayon. Installations of evaporating systems have saved enormously in the preparation and use of coagulating baths. More effective winding machines have partly obsolesced the bulky, expensively operated reels.

RESEARCH for improved quality has taken several courses not the least important of which is that of more rigid inspection. Use of metallic salts or certain organic compounds in conjunction with the usual coagulating materials has given better "feel" to the product. In twisting, the stroboscope has permitted synchronization of all spindles with greatly improved twist control. Studies in the preparation of the xanthate and the precipitation of the thread have been responsible for enhanced wet and dry strength.

GREAT diversity of aims is seen in connection with improvements in appearance. These have included the development of a number of new products closely related to ordinary rayon, among them, staple rayon, a wooly-appearing spun yarn, immunized rayon, hollow fiber and delustered rayon. The first is made by the simultaneous extrusion of a large number of fine filaments which are later cut into short lengths, carded and spun into yarn as is cotton or wool, with or without the admixture of some natural textile fiber. The second is rayon of ordinary appearance which, through chemical treatment subsequent to extrusion and dehydration becomes immune to direct-to-cotton dyes and hence is susceptible to many unique dyeing effects when combined with the ordinary product. Hollow fiber, a recent European development, results when gas is allowed to form a hollow core in the individual filaments at the time of extrusion. The fiber when deflated is flat and presents a greater strength and exceptionally pleasing appearance. The last fiber, delustered rayon, is the result of a tendency in popular taste away from the typical metallic sheen of ordinary rayon to the more subdued glint of natural silk. Various projects have been worked out depending upon decreased continuity or otherwise changed character of filament surface and has enabled the producer to market a fiber that can be distinguished from silk by appearance only with considerable difficulty.

Tendencies in rayon point to the development of new raw materials to give a product of greater strength. Acetate rayon, because of its superior character in this direction, has become increasingly popular despite the greater cost. Two of the country's largest viscose producers are turning toward acetate rayon to represent a part of their manufacture. Other trends indicate the probable combination of certain chemical steps to reduce cost, time of processing, and handling. The next few years are likely to see considerable improvement in strength and appearance and through the application of colloidal chemical principles, there should result a fiber which will make an increasingly stronger bid for feminine fancy.

Sulphuric Acid Manufacture Shows Development

PERHAPS the outstanding development to appear in recent years in connection with sulphuric acid manufacture is the final perfection of vanadium catalysts to take the place of the expensive and easily poisoned platinum catalysts used in the contact process. Vanadium compounds have long been recognized as a potential source of contact material but it is only within the last year that satisfactory contact masses have been produced therefrom. Besides their comparative cheapness, the vanadium contact materials are not poisoned by arsenic compounds and chlorides as are the platinum catalysts. *Chem. & Met.* has described in the issue of March, 1928, page 153, the vanadium catalyst developed by the Monsanto Chemical Works.

Another improvement in catalysts has appeared in connection with the chamber sulphuric acid process. This consists in the oxidation of ammonia to produce nitrogen oxides which may be introduced into the first chamber instead of employing the older practices of potting niter or adding mixed or nitric acid to the Glover tower flow. While it is not newly understood that the oxidation of ammonia can be made to take place under the influence of heated platinum gauze, recent years have witnessed economic changes that make a change in the source of nitric oxides desirable. Various workable processes have been introduced as a result. That brought out by the Chemical Construction Company has been described by S. F. Spangler in *Chem. & Met.*, June, 1928, page 342.

ANTIQUITY OF MODERNIZATION

¶ PREACHING is an art as old as the world and from time immemorial the giver of advice has been little loved and seldom heeded. Yet constant preaching eventually commands attention. It is significant that one of the world's oldest builders was a most prolific giver of advice—even on so modern a subject as "modernization."

¶ IN BIBLICAL TIMES, after Solomon had built his temple with the aid of his consulting engineer, King Hiram of Tyre, he sounded this warning to his contemporaries: "Yet a little sleep, a little slumber, a little folding of the hands to sleep, and so shall thy poverty come."

¶ IN THIS ISSUE *Chem. & Met.* also preaches modernization, but realizing the futility of easily convincing its readers by such methods alone, the sermon has been supplemented by numerous and striking examples of what others are doing. Envy has often proved a stimulus to progress. Stories of advances by others are at least disturbing to one's own peace of mind and they sometimes prove provocative of similar strides forward.

¶ "YET A little sleep, a little slumber" coupled with a feeling of self-satisfaction and personal excellence—have been the forerunners of many industrial disasters.

CONSTRUCTION MATERIALS

IT IS IMPOSSIBLE to characterize the development of recent years in any field of technology without stressing the phrase "mass production." In practically every industry machinery has multiplied manpower, leaving to man the ultimate control, but relieving him in large part of the necessity for a strong back and prodigious biceps. It is no less true of the chemical than of the mechanical industries that constructional materials are the muscles of the new order. With the former, however, is emphasized the requisite of muscles with more than brute strength, muscles resistant to the destructive forces of corrosion and erosion, not only at low but at high temperature and pressure.

Lacking the new constructional materials as we know them today, it is inconceivable that chemical engineering development could ever have achieved its present position. This is not the work of any one class of material. Metals, singly and in combination as alloys, glass, silica, ceramic materials, refractories, portland cement, rubber, synthetic and natural plastics, coatings—organic and inorganic—and other new or improved substances in almost infinite variety have all contributed.

If it were necessary to award the palm for general utility to any one class of materials, the choice would probably fall to the metals in general and the chrome-iron alloys in particular. With the surface of this science almost unscratched, it is certainly to the metallurgist that the chemical engineer of the future will turn for the bulk of his plant and apparatus requirements. Meanwhile, the metals and alloys enjoy no monopoly. An attempt is made below to bring together the views of engineers versed in the application of a number of these material groups with a view to showing some of the diversity of uses within any division.

Rubber Coverings Shield Equipment from Corrosion and Abrasion

By H. E. Fritz
B. F. Goodrich Rubber Company, Akron, Ohio

WITHIN recent years engineers, both within and outside the rubber industry, have begun to appreciate the possibilities inherent in rubber for use as a structural material and as a lining material for chemical engineering apparatus. Previous to that time the chemical engineer was allowed to find for himself and select what rubber equipment he required as best he could. Now, however, the rubber industry has learned to specially design and compound all rubber equipment with a view to the service involved and the life expected.

The range of physical properties, uses and costs of many different rubber compounds is probably as great as the variation in iron and steel and their alloys. It is for this reason that rubber products must be carefully selected with consideration to the duty involved, while a suitable compound must be chosen with the aid of experiments and the help of past experience.

Rubber has many admirable properties and its resistance to corrosion and abrasion is its chief appeal to chemical engineers. However, lack of rigidity and tensile strength have always presented a difficult problem in the utilization of rubber in making use of these properties. To a certain extent, nevertheless, the new Vulcalock process of bonding soft rubber to metal has overcome these limiting factors with the result that the field of rubber in chemical equipment is becoming daily more extensive.

The chemical and allied industries have long felt the need for a corrosion-resisting construction material which would withstand severe operating conditions for appreciable periods regardless of shock, strain and vibration. Such a material would greatly decrease replacement and maintenance and might, possibly, lead to the resurrection of a number of chemical manufacturing processes which have necessarily been discarded as the result of mechanical construction difficulties. If existing metals which present great strength and suitable workability could be imagined as corrosion-resisting, they would be ideal, but it is very doubtful that such a universal material will ever be discovered. When, however, rubber is combined with metal, under many circumstances this ideal is very closely approached. Rubber is now effectively resisting without contamination, all the acids except nitric, acetic, highly concentrated sulphuric and phosphoric. It may be used successfully with 50 per cent sulphuric and 75 per cent phosphoric acid. The common corrosives and numerous salt solutions present no problem at all when stored and transported in rubber lined containers. Temperature limitation is frequently the only factor which is likely to cause difficulty, as temperatures of 100 to 150 deg. F., dependent upon the corrosives, are the upper limits for conservative practice in most cases.

Except when it is under tension, rubber has remarkable abrasion resisting properties. For this reason it has proved extremely useful in a large number of cases. For example, the shell of a large grinding mill in a cement plant was lined with flat sheets of rubber 1 inch thick. After fourteen months of continuous service the lining was found to have worn not more than $\frac{3}{4}$-in. at

any point despite the mill's load of 45,000 lb. of steel balls.

The Vulcalock process makes it possible to attach soft rubber to metal with a degree of adhesion closely approaching the tensile strength of the rubber. This strength has been found to exceed 700 lb. per sq.in. The process brings into use a new industrial material which incorporates the strength and workability of steel with the desirable abrasion-resisting properties of rubber. Again, the limiting factor for rubber attached by the Vulcalock process, as in the case of ordinary rubber linings, is temperature which must not exceed 150 deg. F.

For many years rubber lined sectional wood tank cars have been the most effective means of transporting muriatic acid. The rough usage of these cars, however, has led to very high maintenance. Quite recently the advent of the rubber lined steel tank car has put an end to this excessive maintenance. Enough of this work has now been done to permit the development of a standard method of lining. The results have been extremely satisfactory, while one of the concomitants of the new equipment is the ability to discharge such cars by the application of air pressure. The use of rubber lined pipe, valves and fittings permits easy handling of the acid from the car.

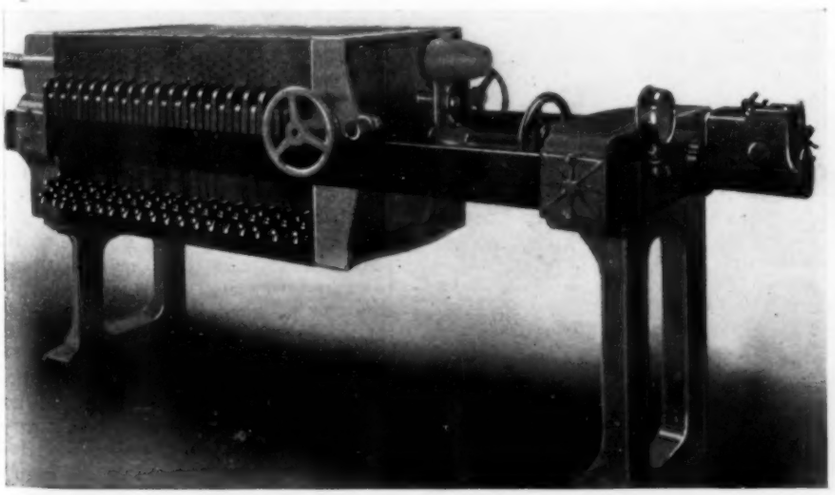
The Vulcalock process may also be used in connection with steel tanks and other receptacles. It may be used in lining standard steel pipe and fittings as well as special valves. All metal contact is eliminated, producing a pipe which resists both corrosion and abrasion. It goes without saying that rubber lined tank and pipe will withstand an internal pressure corresponding to the strength of the metal. For this reason, tanks may be discharged and the contents may be transported safely by air pressure, thus eliminating pumping.

One very successful application of rubber covering lies in its use for chutes for abrasive materials. In a number of cases such chutes have outworn the equivalent thickness of steel by ten times. The oldest installation is about two years old and has been handling 1,000 tons of gravel and sand daily. The rubber liners have not worn down more than $\frac{1}{8}$ inch in this period of two years. Another development which is not yet complete but which may be expected to yield excellent protection in the future is the covering of fan blades for exhausters. Due to the high tension exerted by centrifugal force upon the surface of the rubber, abrasion is not resisted sufficiently in the present applications. Fans, however, for the handling of corrosive gases where abrasion is not encountered to any extent, are an outstanding development and there are many of this type of equipment in service giving good account of themselves and reducing maintenance and production costs materially.

In connection with the use of rubber lining in grinding mills, particularly ball mills, it should be noted that rubber linings are not universally suitable. In operations in which considerable heat is generated, such lining may be unsatisfactory. Similarly, severe impact will destroy the structure of rubber, although this may be offset by increasing thickness of the rubber lining. From many tests it may be concluded that rubber lining is best suited for cylindrical type mills using the wet process of grinding of fine material, requiring small balls which thus give a large grinding surface. The rubber lining has been used in the portland cement industry for secondary wet process grinding. Comparative tests have shown that rubber lined mills have a slightly increased efficiency over the ordinary type. Power is saved by the reduced slippage of the grinding media in the shell and by the substantial difference in weight between rubber and steel linings. Rubber lining probably finds its ideal application in ceramic grinding operations because of the virtual elimination of contamination of white pigments. The smaller mills may frequently be lined by the Vulcalock process, whereas a special detachable lining may be supplied in other cases.

Another recent development in the use of rubber lies in the manufacture of rubber filter press plates and frames. This was worked out by the B. F. Goodrich Rubber Company in collaboration with T. Shriver & Company. The standard for handling many corrosive substances in the past has been the ordinary filter press skeleton filled with wooden plates and frames. While these have been quite satisfactory in many installations their maintenance cost has been exceedingly high. It had been thought that rubber because of mechanical difficulties would be unsatisfactory. However, a proper control of the rubber stock of a semi-hard condition has produced a plate and frame which will withstand any ordinary pressure up to 65 lb. per sq.in. Such presses form a perfect seal and permit no leakage. The ports may be arranged for any type of filtering. Again, within the specified temperature limit, most inorganic materials and several organic liquids are handled satisfactorily. The rubber is tough, rigid and non-breakable. It has long life and requires infrequent replacement. It is easy to handle and not particularly expensive.

While the above brief discussion has not attempted to cover the field of rubber in chemical engineering equipment in more than a superficial manner, one further application should be mentioned. This refers to the use of rubber in the new "cutless" type of bearing. The new bearing, lubricated by water, has many applications outside of the chemical engineering field, and in the field has given remarkable service in connection with centrifugal pumps for abrasive service. Journals running in such bearings have a tendency, like a famous automobile engine, to improve with use



Shriver Filter Press Equipped With Rubber Plates and Frames

Glass Enameling Prevents Metallic Contamination

OF THE many new alloys which have appeared upon the market within the last few years none have proved to be cure-alls and many have been found to be difficultly workable for fabricating purposes. The Pfaudler Company has commented that, in the light of these limitations, alloys have given no serious competition to glass enameled steel equipment. The multiplicity of uses to which glass enameled equipment may be put is one quality which has appealed particularly to the manufacturer of fine chemicals and pharmaceuticals. These manufacturers must change their methods of manufacture and the character of the products so frequently to meet trade demands that it is necessary for them to employ equipment resistant to many different corrosives.

Glass enameled apparatus, avoiding as it does the possibility of metallic contamination, is particularly adapted to those industries making products of such delicacy that not even minute contamination is allowable. This class includes the manufacture of essential oils and perfumes, many of the food industries and certain processes of a bacteriological nature. "Seed" tanks, especially, in the latter are frequently glass enameled.

Phenol Resinoids Gain Prominence in Equipment Construction

By L. V. Quigley

Bakelite Corporation, New York

IN ITS PROGRAM of modernization, chemical industry has probably found no other group of materials so versatile in their utility as the synthetic resinoids. Aside from their value as insulation materials, the adaptability of the molded, laminated, and varnish products has been evidenced in the numerous cases where they have been used to replace wood, fiber, paper, metal, rubber, and other "natural" materials.

The Bakelite Corporation, through its research laboratory, headed by Dr. L. V. Redman, one of the pioneer chemists in the phenol resinold field, has studied many problems far removed from electrical insulation, the field which first made use of Dr. Baekeland's invention. During the past year, a new molding material has been introduced in response to a need for a material with a high degree of mechanical strength, particularly shock resistance. Textile bobbins, tool handles, and silk bobbin cones have been made of this product. They will not break even when dropped or thrown upon a concrete floor.

The replacement of other materials by phenol resinoids in the construction of industrial chemical equipment, may be considered from two viewpoints: (1) equipment as now being supplied; (2) the repair of existing equipment to prolong its period of use, or in other words to defer the time when it will become obsolete.

In a consideration of the various equipment units utilized in the process industries, it will be found that one use of the phenol resinoids is common to them all. This use involves the impregnation of linen, or canvas sheets, with the resinoid varnish to produce a laminated product. From this material, gears and pinions are machined, varying in size from very small face diameter up to three feet or larger. These gears have been used quite universally in connecting the electric drive to whatever plant equipment is to be operated, be it a large ball mill or a small stirrer for electrolytic operation. The material affords requisite strength coupled with silence of operation. Depending upon conditions, however, its inertness and resistance to corrosion may constitute the chief reasons for its use.

Following the established use of Bakelite laminated gears for the drive of industrial equipment, it is natural that they have come to be used on the equipment itself.

A felt sizing machine made by the United States Hat Machinery Corporation, New York, involves in its construction a series of rollers driven by small spur gears, which are all actuated by a spider gear wheel of large diameter. A weak solution of nitric acid and mercury is handled. It was found that splash and fumes from this solution, coupled with electrolytic action caused by contact of one metal gear with another, soon resulted in corrosion. The life of the gear train was correspondingly short. Bakelite laminated intermediate gears were installed. Being both inert and insulating they were effective in prolonging the operating life of the machine.

Next to the laminated gears in importance or generality of use come the Bakelite liquid materials, notably varnish and enamel. Resinoid surface coatings provide corrosion resistance, electrical insulation, or help to make the surface more resistant to mechanical wear. They find their chief use in the unit processes of liquid handling, mixing and agitating, filtration, evaporation, and drying.

In the production of toothpaste, one manufacturer used a glass lined mixing tank equipped with an impeller assembly made from alloys supposed to be acid resisting. Corrosion shortened the life of the impeller and in addition, introduced a metallic contamination problem. Early in 1926, it was decided to coat the impeller assembly with Bakelite varnish. At the end of 1927, after continuous use, the metal was found intact, and there was no evidence of corrosion. The formula of the toothpaste indicates that it contains glycerine, with hydrochloric acid and tartaric acid specified in small amounts.

In filtration, phenol resinoid enamel has been applied to the filter press plates of a unit handling oxalic acid.

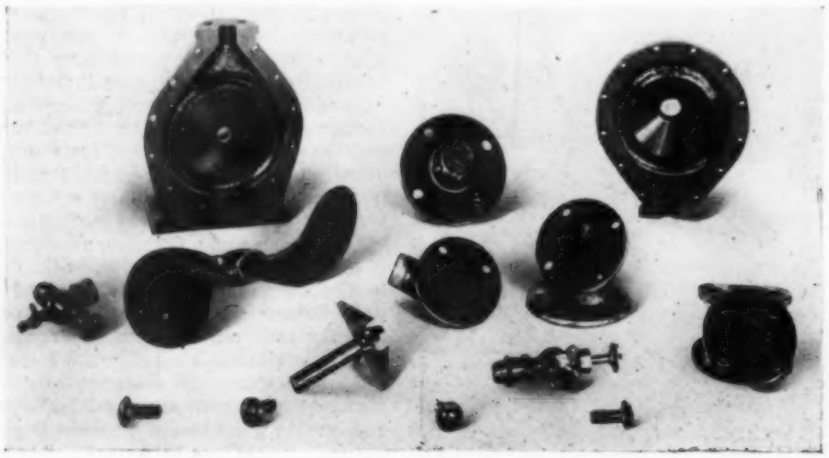
In evaporation and drying, there are numerous examples wherein phenol resinoid varnish or enamel has served to protect metal surfaces. The life of aluminum dryer trays exposed to the fumes of sulphuric and hydrochloric acids has been successfully extended by surfacing them with phenol resinoid enamel. Similar application of the enamel has been made on a unit handling acetic acid.

Less generally used in the chemical industry than the Bakelite laminated gears, or the protective varnish, is the molded product. Although this material has thousands of uses in the mechanical and electrical fields, its industrial chemical applications thus far have been limited to such items as valve handles and agitator paddles. In the laboratory it is of course well known, being used on a large number of precision instruments. The era of its use as an important material of construction in the unit process industries has probably just begun.

As an example, Bakelite molded agitator paddles have been found unimpaired after many months of intermittent service in copper and nickel plating solutions. In one instance, the propeller had formerly been made of a shellac composition.

Another example comes from a paper mill. In making paper, approximately two pounds of water is evaporated on the dryers for every pound of paper made. The moisture driven off contains sufficient traces of corroding materials to attack metal. In suspending the fume roofs or "hoods" over dryers, it was found that suspension by steel bolts was temporary at best. Bakelite studs were molded which would serve permanently to support the fume roof. The molded studs engage with the steel bolts in such manner as to protect them from corrosion. Better distribution of roof load was accomplished. The phenol resinoid roof supports are heat-insulating, and prevent water from condensing and dripping to the paper below.

The trend toward the adoption of phenol resinoids for unusual services in which wood, metal or other materials were formerly employed, may be an important feature within the next decade in equipment construction. It is significant, for instance, how important a factor in determining the life of an all-metal operating unit may be the resistant enamel which serves to prevent premature obsolescence. When other substances fail, the phenol resinoids, in one form or another, will frequently be found to provide the logical solution in prolonging useful equipment life.



Bakelite Varnish Increases the Life of These Impeller Parts

How Stainless Steel and Iron Aid in Modernizing Equipment

By J. C. C. Holding

Manager, American Stainless Steel Company, Pittsburgh, Pa.

STAINLESS STEEL and iron are of comparatively recent origin, having been discovered and practically applied to manufactured products only a little more than ten years ago. The reception which the material received and the remarkable progress it has made, modernizing, in fact, revolutionizing many industries, is now a matter of history and this history is one of the fascinating romances of industrial metallurgy. Judging by the developments of the past ten years and the momentum which these materials have already gained, the next decade will see tonnages mounting rapidly as industry recognizes the ultimate economy of using a permanent material, even though its first cost may seem excessive.

Corrosion, from every angle, is a serious matter. Many attempts have been made to minimize or overcome it, but for many purposes the most successful and efficient method yet discovered is the alloying of chromium with iron to form stainless steel and stainless iron, materials discovered independently and almost simultaneously by Harry Brearley and Elwood Haynes in 1914. These materials have the great advantage of homogeneity and their non-corrosive characteristics are inherent throughout the molecular structure. They, therefore, do not depend upon plating nor any artificial means of protection and can, as a consequence, be fabricated into practically any form of product desired.

In addition to its corrosion resisting properties, the physical properties of stainless steel (or stainless iron) render it a most valuable material of construction, enabling the engineer and designer to reduce the weight of his structure or equipment while at the same time increasing its serviceability. These valuable physical properties are retained at elevated temperatures, a fact which renders the material most useful in the chemical engineering industries. The alloy's freedom from scale when heated to high temperatures is another strong recommendation for its use in these industries. Its efficacy and its permanence are guarantees against frequent replacements, lost time due to shutdowns and consequent curtailed production. It is particularly true in these industries that a permanent installation is more to be desired than a cheap one, for the lasting one is the cheapest in the long run.

One of the outstanding recent applications of chrome-iron alloy in the process industries is its use by practically all of the builders of oil refining equipment for valve parts. Its value in this field was quickly recognized when one courageous pioneer announced his intention of specializing in the production of stainless mounted valves for oil refineries. The alloy's splendid service here is due to its corrosion resistance under high temperatures and high pressures in the handling of extremely corrosive liquids and gases.

Stainless iron is practically immune to attack by nitric acid and has, therefore, proved to be an ideal material from which to fabricate pressure tanks, digestors and similar equipment for its use, and is now extensively used in the modern methods of producing the acid. The two largest factors in this industry now specify stainless iron when ordering their equipment.

In the past it has been necessary to resort to coatings as a means of protecting equipment for handling food products. This has been necessary as well in protecting the materials handled from contamination by absorption of injurious tastes or odors from contact with steel, iron, brass or copper containers. Iron-chromium alloys, however, require no such coatings as Stainless is not attacked by the majority of corrosive agents that are present in fruits, vegetables, milk and so on. Modernization in the canning industry will see increasing use of stainless steel and iron for process equipment in insuring conformity to the high standards of purity and cleanliness demanded by the consuming public.

One of the most recent developments is a thorough test of stainless iron in the building of tank cars for the transportation of milk. It will be surprising, indeed, if within the next few years we do not see great strides made in the application of stainless metals, not only to milk cars, but to many other forms of equipment for the dairy industry. Between the chemical industries, the food industries and other applications requiring high resistance to temperature and corrosion, future applications of these alloys are almost without limit.

Better Refractories for High Temperatures

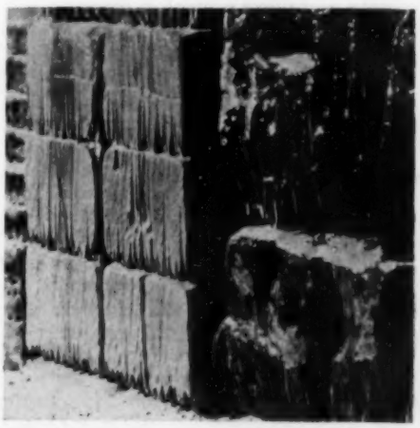
THE DEMAND for higher temperatures, not only in the production of power but in connection with many chemical processes, has practically forced the development of an entirely new group of refractories. Without attempting to go into the subject exhaustively, it is well to mention, for example, the new cast refractories of mullite. Mullite refractories may be made by fusing alumina and silica bearing minerals in an electric furnace; or by heating clayey materials at their maturing temperatures, though the mullite content of refractories made by the latter method is likely to be very low. The fused mass may then be cast to shape with extreme accuracy, eliminating the necessity for laying up the blocks in fire clay.

Mullite refractories may be used in most cases where fire clay refractories are possible. They are more satisfactory for extremely severe conditions than are the latter. At present the use of cast mullite blocks in glass melting tanks has had most encouraging results. The life of the blocks has been determined to be more than twice that of ordinary glass tank refractories. Electric furnaces, muffles, enamel furnaces and checkers in water gas carburetors have been suggested as other uses for mullite blocks. The Corhart Refractories Company of Louisville has recently completed a plant for manufacture of the blocks.

Refractories compounded from silicon carbide have likewise received much attention. As an example, one company was confronted with the necessity of calcining a large quantity of an oxide pigment containing a very high percentage of water. The calcination was to be carried out at a temperature of 1,750 deg. F. for a period of 30 minutes. Longer heating tended to cause discoloration. A Carborundum muffle furnace, similar to the type used in porcelain enamelling furnaces, was designed and built, and is understood to be operating satisfactorily.

Alundum refractories are also increasingly used. In one case the modernization of a continuous kiln for firing pottery resulted, not from the use of a new refractory but from the adaptation of a different structural shape of alundum plate. Where previously 2-in. solid slabs had been used in the construction of the muffle, ¾-in. Norton corrugated sections were employed with the result that the temperature lag through the muffle was considerably reduced and the temperature in the combustion chamber was lowered as much as 150 deg. F. The new corrugated muffles are believed to be a distinct improvement.

There remains much to be desired in the field of extremely elevated temperatures. In the range 2,000 to 2,500 deg. C. special refractories of zirconium and chromium oxides are satisfactory. Carbon refractories, provided the furnace atmosphere is non-oxidizing, are useful to temperatures not in excess of 3,000 deg. C. No known material, however, can long withstand a temperature greater than this.



Panel of Cast Mullite Blocks in a Glass Tank
The mullite (light panel) shows much better resistance than the ordinary refractories at the right

Fusion Welding a Factor in Fabrication

AS IMPORTANT as suitable materials of construction for chemical engineering equipment are the means taken for jointing the materials. Much equipment can be cast from various metals but the part that is played by sheet and plate metal is one of ever increasing importance. This is the logical result of the advent of high pressure technology. With such difficult service comes the incubus of jointing. Riveting, formerly the recognized solution to the problem, has disadvantages which, in the face of competing means, are gradually being found to outweigh the advantages. It is in the use of fusion welding that the greatest advances in equipment fabrication may be expected.

The advantages of one-piece equipment are many. Welding of joints permits construction of lighter equipment which is nevertheless stronger than the same apparatus fabricated with rivets. Joint maintenance approaches the vanishing point. Equipment cost is lessened and safety is enhanced. It is not beyond the realm of possibility that the welded joint will fairly obsolesce the rivet within a decade or two.

Fusion welding through the use of the electric arc and the gas flame offers the greatest possibilities for most purposes. Hammer welding has its applications but it is questionable whether its use will not largely be superseded in the case of chemical equipment by the fusion weld. Alumino-thermic welding is not applicable in the great majority of cases. This leaves gas and electric arc welding almost completely in command. The field of usefulness of the two will overlap in some departments, but it is to be expected that the former will be used, in the main, for the heavier work, while the latter will see its biggest field in the joining of thinner plate and sheet metal.

A happy combination of the two types of fusion weld is the atomic hydrogen arc process developed by the General Electric Company. The possibilities of this method have not been completely worked out, but it is certain that thinner sheets and more difficultly weldable materials can be handled by its means than by either of the other fusion methods. It is equally certain that it will not attempt to compete with gas welding in the majority of cases of heavy construction.

Electric arc welding has now been used in the construction of piping, tanks and gas holders. High pressure gas transmission lines have been fabricated by its use. This quite possibly does not indicate the limits of application of the arc. More data is available, however, in the field of chemical construction, for gas welding. The uses in this case, such as for equipment for petroleum refining and the production of solvents are more spectacular. It is reported, that at one plant of the latter persuasion, practically everything that is weldable has been welded. High pressure equipment such as autoclaves, digesters and large piping is particularly susceptible to the welding torch. A degree of safety unattainable in riveted equipment, on the one hand, and screwed or flanged joints for piping on the other, is a certain companion of the properly executed weld. This alone, were it not also for the accompanying advantages of weight and cost reduction, should be enough to bespeak this modern means of fabrication in terms no engineer can afford to disregard.

Monel Metal and Nickel Often Exceed Cheaper Materials in Economy

By R. J. McKay

International Nickel Company, New York

THE ECONOMY of the higher cost alloys, such as special bronzes, the alloyed iron compositions, Monel metal and nickel depends, of course, on the assurance that the higher first cost can be compensated for by longer life, by lower maintenance costs, by the avoidance of shutdowns for repairs, and—in many cases the most important—by the more difficultly mensurable factor of product purity. In chemical and related industries, the far flung utility of Monel metal and nickel attest the relative unimportance of first cost in the face of these modifying factors. These metals, with mechanical properties that place them high in the list of structural materials, and working properties of a very versatile nature, are chemically among the most stable. In this combination of properties lies the basis of their worth. Power laundry machines use annually hundreds of thousands of pounds of Monel metal because clothes must not be spotted with rust or green patches. Tons of nickel are used annually in milk handling equipment, since the products must not be discolored, flavored, or made toxic. The large quantities of Monel metal consumed in the textile industry are necessary in the sensitive coloring of cloth.

In the innumerable individual corrosion problems of the chemical plant, Monel metal and nickel pipe lines, valves and fittings, containers and tank linings, screens and wire cloth, pumps, fans, and ventilator hoods are continually arguing for the economy that lies in the avoidance of interruptions, in low maintenance and repair costs, and in the high quality of the plant's product.

A prominent example of the changing viewpoint as to where economy really lies is that of the several recent installations of nickel caustic evaporators. Predominant in bringing about nickel construction in the face of greater first cost has been the increased life factor, although related to this are improvements in the matters of repair costs, shutdowns, quality of the caustic and so on. The life of steel tubes in one case was demonstrated to be under a year and of copper tubes less than two years. The estimated life of nickel tubes, after very careful consideration of all phases of the exposure conditions, was several times the minimum required to compensate for first cost differences.

It is not commonly possible, or necessary, to compute the actual advantage in total cost of a material whose first cost is relatively high. This has been done with care in the case of Monel metal Jordan fillings in a prominent paper mill. Steel fillings suffered seriously from erosion and corrosion, their life averaging six months; in addition, the inevitable rusting of steel was very undesirable from the standpoint of discoloration of the paper. Bronze fillings were better, their average life being about three years. The difficulty with bronze lay in the burring of the knife edges. Filing and chipping costs were relatively heavy. Monel metal blades have a life, in this particular plant, of seven years, conservatively figured. Abrasion, uneven wear and corrosion were definitely less, discoloration was obviated, and a greater consistency in the refinement of the stock was obtained.

The total costs per year of the three materials, taking into account the first cost of material, replacement labor, and labor connected with filing and chipping, and deducting scrap values, were as follows:

Steel	$931.00
Bronze	530.59
Monel metal	215.14

The advantage of Monel in costs was exclusive of the advantages in the quality of the product possible with its use. It is very interesting to note also that the material cost per filling for steel was $361.50 and for either Monel metal or bronze, $1,440.95 and that the labor costs per year were as follows:

Steel	$208.00
Bronze	50.27
Monel metal	9.29

Monel metal pump rods and shafts are used on plunger and centrifugal pumps handling all manner of solutions. Almost invariably the greater cost of the Monel metal as compared with steel and bronze is more than compensated for in the longer life obtained, the decrease in upkeep and repair costs, the assurance against contamination of one sort or another, and the dependability and consequent avoidance of shutdowns. In one plant, where the first cost of pump rod installation amounted to $5.00 for steel and $15.00 for Monel metal, the average life was found to be one year and five years respectively. More important, the yearly cost of repacking was $20.80 for steel and only $0.80 for Monel metal. Reductions of 85 per cent in maintenance cost are perhaps not matters of everyday occurrence in most plants, but this example suggests certainly that most plants may benefit by experiences of this nature.

SEPARATION

CHEMICAL ENGINEERING, in the nature of things is, to a considerable extent, a borrowed science. From the chemist it has taken technique and many unit chemical processes. From the mechanical engineer comes its applications of heat and cold—power services—and much in equipment construction. The mining engineer has contributed largely to the fundamentals of one group of processes without which scarcely a chemical industry could exist. Separation blankets the process industries more fully perhaps than any other unit operation.

Classifying, filtering, screening, dialysis, thickening and dewatering, diffusion, sedimentation and differential settling, magnetic separation, centrifugal and air separation all represent important divisions of the general heading. Not one but has experienced some improvement during the last decade. Some are highly developed—all are in a state of transition, not only in *modus operandi* but frequently in application. New processes appear, old ones are revamped. Better separation, easier operation, lower maintenance and operating costs are demanded. The following pages will give some conception of the way these transitions are affecting a number of the types of separation most frequently used by the chemical engineer.

Filtration Modernizing Aims at Automatic Operation

By Arthur Wright
Filtration Engineers, Incorporated, New York

WHEN we consider the advances made in the unit process of filtration and its part in the modernizing of manufacturing operations in the chemical industries, we are struck with the tremendous strides that have been made in the past two decades and the evolution that is taking place in this year, 1928.

In number of years it is not a long time since George Moore first introduced his cyanide process wherein the recovery of rare metals was made possible with an economy that practically revolutionized cyanidation. The idea he established with the uninterrupted formation of the solids on the filtering member gave rise to the pressure leaf filter first developed by David Kelly and more firmly established by E. J. Sweetland. Moore, himself, appreciated the possibility of continuously effecting the work that his machine obtained by intermittent operation, but it remained for E. L. Oliver to develop and make possible continuous operation of Moore's principle.

It is only ten years ago that the American Continuous Filter was first put on the market and in the ensuing years, we note the increasing tendency toward continuous filtration. Five years ago marked the installation of the FEinc filter with its discharge by conveyance of the cake. Today, every manufacturer desires and strives to have continuous operation for his filtration; and it is a timely subject—this continuous and automatic operation—for there are factors underlying the application of automatic filters in addition to the obvious labor saving feature.

The objective of every superintendent of a manufacturing operation is to have his plant maintain a continuity of production with minimum executive control. Automatic filters relieve the operator from the control of the filter performance as he has no valves to operate, no pressure to watch, no time cycle to maintain, but simply is an observer making sure that there is slurry to be filtered, that the filtering force of vacuum is maintained and the mechanical operation kept constant by lubrication, tightening of stuffing box glands and so on. The machine, which has been designed to do the specific job required of it, is controlled by the setting of a valve; by maintaining a fixed vacuum; by controlling rotative speed, wash application and the other details—not by the filter operator but by the executive in charge of the department. This feature of eliminating the operator's control is a mark of modernization that is being appreciated throughout this country and throughout the world.

It is interesting to note that the German manufacturers require only that newly available equipment shall effect an economy, better the product or maintain more uniform production when obsolescence on previously installed equipment is immediately and automatically reached, even though the installation of the existing equipment was made only within the previous year.

With the adoption of automatic filtration, the application of the filter depends upon the filterability of the slurry. This is always a matter of chemical control. Those factors that vary the production from the filters, such as concentration of solids, viscosity of filtrate, temperature of slurry and nature of precipitate, are all therefore kept in the hands of the chemical control. This is a modern concept of manufacture which intensifies the value of the chemist and enables him to change his slurry if there is a change in the raw product or a change in the desired final product, so as to maintain always the optimum condition for filtration.

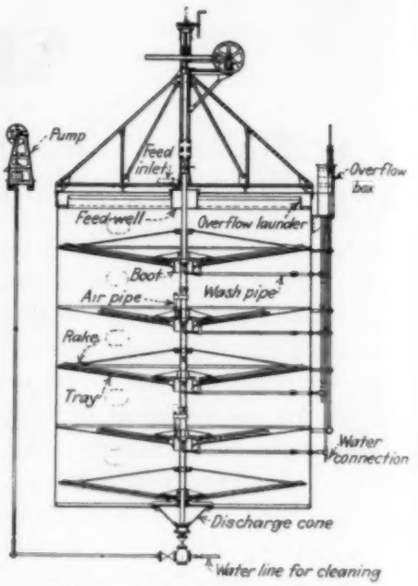
Filters are mechanical devices designed to do specific jobs and are therefore capable of best operation within certain limits only. To overload a filter in the duty it is required to perform is widely realized these days as poor manufacturing. Out of this concept comes the appreciation that the filter duty is very much tied up with the subsequent process to which either the solids or the liquids will be subjected. This feature of filter operation is hardly a modern concept, but it is so much better appreciated by the manufacturers of the present day that it marks a modernization of the manufacturing processes.

We find an instance of the coupling of filtration with a subsequent process in the dewatering of wet slurry in cement manufacture, so as to provide a feed of dewatered solids to the kiln. The specific duty of the filter here is to decrease the water to be evaporated in the kiln. It is found that mechanical dewatering is limited, depending upon the nature of the slurry, to a certain moisture content. It is found likewise in the economical handling by the filter, that the moisture content is not quite equal to the final dewatering possibility. The difference may be only a fraction of a per cent in moisture content, but this small difference in moisture may cause the texture of the cake delivered from the filter to vary widely. The cake may be plastic in one

instance and relatively granular and free from plasticity in the other. This latter condition must be obtained or else the economic saving in the reduction of water is balanced by loss of production due to mud rings, spilling back or clogging of the feed to the kiln. The filter for this job is far better considered as a conditioner for kiln feed than as a dewaterer of the original slurry. The comprehensive work of the filter is therefore dewatering the slurry and conditioning the solids fed to the kiln.

In all of the work in applying automatic filtration to chemical slurries it is to be noted that success is primarily founded on the efficiency of the discharge. A filter which steadily falls off in production until it finally reaches a point where the cloth is clogged and must be removed is not a true embodiment of the modern idea of continuous and automatic filtration. Filter cloths naturally have a finite life and must be renewed, but if they are clogged before they are deteriorated, then much of the advantage of continuous and automatic filtration is lost. The thought may be old but it is really modern to conceive of the filter as a machine effectively discharging its cake. The savings made in modernization by automatic filtration are too easily lost by filter maintenance cost and uneven production to neglect constant emphasis of the need for complete discharge from the filter.

What economic advantages are expected from the adoption of automatic filtration is surely a matter for each plant to determine for itself, but past experience proves that automatic filtration pays a handsome return on its investment. New applications for continuous machines are being discovered every day, as further investigations are inaugurated. In the interests of maintaining the position which American industry has gained in the world chemical situation, it is well that every manufacturer look to the modernization of his filtering operations.



Detail of Washing Type Thickener

Extremes of Size Characterize Development in Continuous Thickeners

By A. Anable
The Dorr Company, New York

DURING the last year or so, two distinct tendencies may be noted in connection with equipment advances in the art of continuous thickening. There has been an unmistakable demand for large, heavily constructed thickeners for handling tonnages far in excess of those which units of this type have previously been called upon to handle.

There has also been a demand for a small and compact thickening and counter-current washing plant, one that would give results comparable to those secured with the conventional layout of four or five thickeners arranged in series, and one that would take up only a fraction of the space required by the older type of plant. These two requirements have resulted in the development of two new types of Dorr thickeners—the traction type thickener and the washing type thickener.

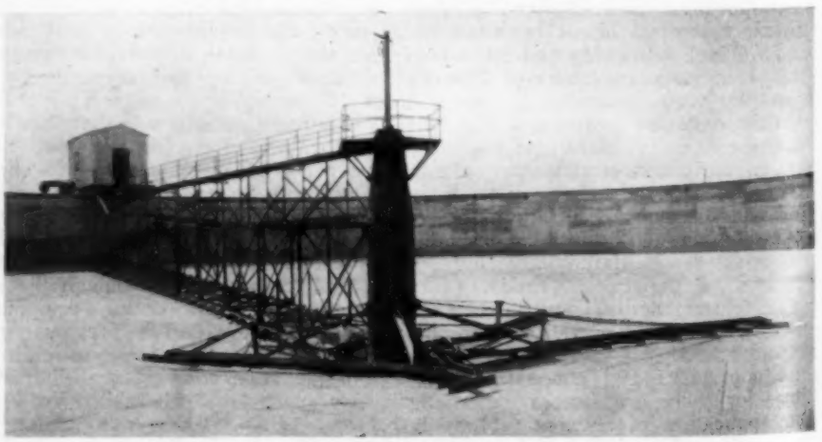
The traction thickener is essentially a heavy duty machine, furnished in sizes ranging from 20 ft. in diameter to 325 ft. in diameter. This latter size does not in any sense represent the limit to which construction may be carried. Some conception of the capacity of these units may be obtained when it is noted that one of the 325-ft. thickeners is now dewatering over ten tons of solid material per minute and is overflowing a clear solution for re-use in the plant at the rate of over ten million gallons per day. In spite of this tremendous capacity the complete machine is operated with only a 5-hp. motor.

The Dorr traction thickener differs from the conventional type of thickener in that there is no central vertical driving shaft. The thickening mechanism is driven by means of a tractor wheel attached to one end of the radial truss and running upon the periphery of the tank.

The mechanism consists of a rotating truss which supports the rake arm to which the plow blades are attached. The truss is supported at its outer end by the traction wheel and at its inner end by a bearing mounted upon a pier which rises from the center of the tank bottom. The traction wheel is directly connected to a speed reducer which in turn is driven by a motor mounted on the truss. Electrical connections are brought in through a pipe in the central pier and transmitted to the moving truss through slip rings and brushes. By driving the truss through traction applied at the outer end, a much more uniform pull is secured than in the old type where a central shaft was used. The advantages of the traction type over the older type are that much more sturdy construction is provided, headroom is cut to a minimum due to the elimination of the usual superstructure and the uniform pull exerted by the traction wheel may be compared to a force applied at the end of a lever.

The washing type thickener is a multi-compartment tray thickener. It differs from tray thickeners introduced previously in that, in the case of the older units, the various compartments operated in parallel in order to give additional capacity per unit of floor space, while in the case of the washing thickener the trays operate in series so that the sludge may be washed countercurrently during its passage through them.

The feed enters the top compartment through a semi-submerged feed well. Settlement takes place with the sludge collecting on the bottom of this compartment while a clear solution overflows from the top to further processes. The sludge then passes by gravity from the first to the second compartment through an opening in the tray which separates these two compartments.



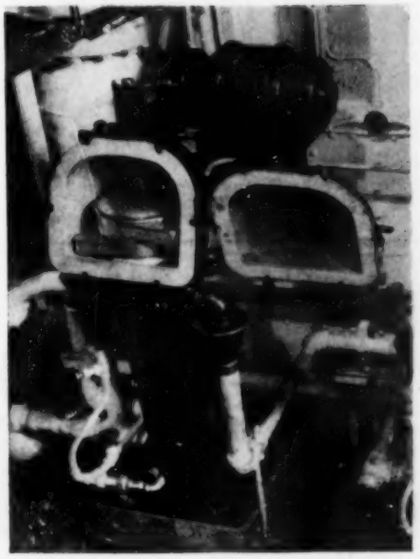
Traction Thickener, 150 ft. Diameter, Used for City Water Purification at Kansas City

This operation is repeated as the sludge passes from the top compartment to the bottom of the thickener tank where it is finally removed by a diaphragm pump in a thoroughly washed condition.

Fresh wash water is introduced in the lowermost compartment and, by means of a series of interconnecting pipe lines and regulating boxes, flows upward, progressing through the various compartments in a direction opposite to that of the sludge. The wash liquor finally overflows as a weak solution from the second compartment, to be used or wasted as desired.

It will be seen at once that the various compartments which make up the washing type thickener operate in exactly the same manner as an equal number of independent thickeners arranged in series for counter current washing.

The washing thickener gives the relatively small chemical manufacturer that same degree of washing on a continuous basis that the larger chemical user has possessed for many years in the conventional type of counter-current washing plant composed of a multiplicity of thickeners arranged for series operation. An interesting example of its use is that made at the U. S. Navy's helium plant at Fort Worth, Texas. At this plant gas is scrubbed with caustic soda solution which results in the formation of a certain amount of sodium carbonate owing to the carbon dioxide present in the gas. This spent solution is causticized with lime and sent to a washing thickener where a clear caustic solution is overflowed from the top compartment for re-use in the scrubber, while the precipitated lime is thoroughly washed in the remaining compartments before being discharged to waste. In another installation, a manufacturer is producing a ferrocyanide from gas house waste. The thickener is used to remove calcium carbonate and calcium sulphate from the solution in the top compartment while the sludge is washed counter-currently in the three remaining compartments of the thickener.

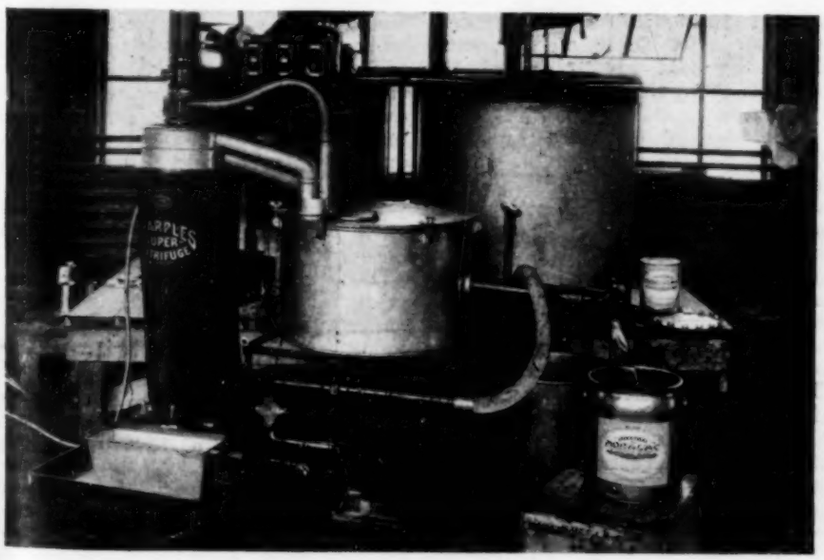


Vapor Tight Super-Centrifuge

Centrifugal Separation Demonstrates Technical Improvements and Many New Applications

RECENT PROGRESS in the field of centrifugal separation has been made largely along the lines of variation and refinement of the older machines to meet the requirements of new types of service. The manufacturers of centrifugals of all types have been alert to the possibility of new applications with the result that we now find many problems in sedimentation, clarification, and separation successfully carried out centrifugally at speeds and efficiencies impossible with the apparatus formerly used.

The super-centrifuge of the Sharples type has been generally used in the clarification of varnishes and lacquers. Refinements of the standard machine now make possible clarification of solvents or solvent carrying materials under vapor-tight conditions. One machine of this type, known as the "Solventite" makes use of a box-like structure surmounting the centrifuge body which encloses the clarification covers. A tightly closed door prevents any possibility of solvent loss as the machine may be installed in close circuit with the solvent using apparatus. The machine is used in such clarifications as the dewaxing of petroleum oils, cleaning dry cleaners solvents, and the purification of fuel oil. The infrequent removal of the solids is easily accomplished by lifting the bowl through the door of the super-centrifuge. The same type of machine may be used under moderate pressure without danger of vapor loss.

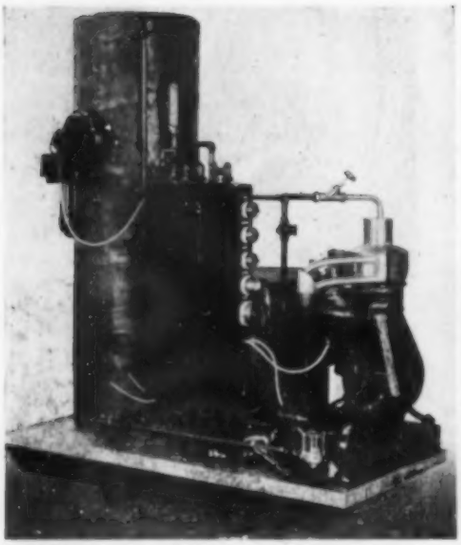


Vapor Tight Type of Super-Centrifuge for Clarifying Lacquer

A second variation of the vapor-tight principle is adapted to the clarification of lacquers. Discharge of the clarified product is made through closed lines to a sealed container whose vapor space is connected back to a look-box surrounding the drive shaft. The danger of solvent loss at this point is obviated by a gland through which the shaft extends.

A new and interesting use of the super-centrifuge is reported from one of the smaller eastern rayon plants where "supers" are being used in conjunction with filter presses in clarifying viscose during the ripening process. As it had been generally believed that such clarification was impossible because of the small difference in density between the particles of cellulose regenerated in ripening and the viscose itself, this development may provide a new and useful tool for bolstering up a difficult step in rayon manufacture.

The De Laval type of high speed centrifugal separator has likewise seen many new variations. Some of these, such as the new horizontal separator for continuous clarification of Diesel engine lubricating oil, have been described in the pages of *Chem. & Met.* One new type is used for continuously skimming oil from the condensate of condensing steam engines in steam-electric locomotives. Of special interest to the lubricating oil industry is the movement for reclaiming automobile crank case oil. It is estimated that of the 300,000,000 gallons of lubricating oil used yearly in the automobiles of the United States at least half a easily recoverable. While only a small proportion is so treated at present, some wonder has been expressed as to the effect which the general use of oil recovery is likely to have on the lubricating oil balance in the petroleum industry. Whether recovered oil is equal in quality to the new has not been



At the Left is an Oil Purifying Unit and at the Right One of the Large Capacity Centrifugals

definitely proved. The treatment is said to be simple and reclamation economical. An apparatus now put out by the De Laval Separator Company provides in one unit means for batch reclamation of fifty gallon quantities. Dilution is removed by evaporation, while neutrality is restored with a caustic wash. The combination of chemical treatment with a final centrifugal clarification is said to remove all contamination.

Another trend in high speed centrifugal separation is shown by the yeast industry. As it is desirable to stop the germination stage quickly and definitely, large capacity separators of a special type are used to concentrate the heavy yeast cells into a small fraction of the "beer," which may then be diluted with wash water and re-separated centrifugally. The yeast cells are finally caught in cloth filters.

With increases in plant capacity, the demand has arisen for larger separators for many types of service. It is only with the development of special alloy steel to withstand enormous centrifugal forces that larger size bowls of the DeLaval type have become available. It is now possible to construct separators with capacities as high as 15,000 lb. of cream or 1,500 gal. of lubricating oil per hour.

Developments in heavy centrifugals point also to refinement of existing types to provide greater ease in operation. What can be done in this direction is shown by an installation of ten 48x24-in. Cresson-Morris machines of the self discharging, open bottom type, now in operation at the Brooklyn plant of the American Sugar Refining Company, and processing 2,700,000 lb. of sugar per day. One operator is able to handle six machines which are operating on a 3-min. cycle. A slip clutch for starting permits throwing the 40 hp. motors directly across the line without starting resistance, while a mechanical brake makes exceedingly rapid stopping possible.

Another tendency in the heavy machines is shown in increased use of the Resines separator, a solid bowl machine which provides for batch sedimentation and continuous liquid discharge through the use of annular baffles within the bowl. It is reported to be used increasingly in sugar juice clarification and in the manufacture of yeast.

Open Bottom Centrifugals Used for drying KCL

Continuous Vacuum Filters Find New Uses in Salt and Paper Industries

By E. D. Flynn
Oliver United Filters, Inc., New York

A RECENT and extensive application of the vacuum-type filter has been evidenced in the pulp and paper industry. Some three years ago the continuous vacuum filter was introduced primarily for the reduction of fiber loss in paper machine white water. This has been one of the most pressing problems facing the pulp and paper industry. The several gravity-flow save-alls which have been introduced have not been entirely satisfactory and the sewer water effluent has not always passed the standards set by the various fishery and river commissions.

It was found that the quick formation of a sheet or mat of fiber on the wire of the vacuum filter built up a most effectual filtering medium, thus allowing recoveries of clay and fiber hitherto unknown. The idea has appealed strongly to paper manufacturers and has quickly won recognition. A very pronounced saving has been effected, some installations having paid the installed cost within six months' operation and all installations have paid their cost within a year's operating time.

Naturally, the introduction of the filter into this field acted as an entering wedge and broadened its scope in the pulp and paper industry. At the present time, continuous vacuum filters are used very effectively in many operations about the mill. For instance, in the handling of lime mud, the sludge may be dewatered and worked practically free from alkali. This results in worthwhile savings and at the same time produces high strength solutions. Again, the vacuum filter is used in washing the paper pulp free from cooking liquors and has effected a great reduction in labor and operating costs over previous methods. Washing on the filter eliminates considerable dilution of the filtrate, thereby saving evaporator costs and chemicals. In mills producing bleached pulp, continuous vacuum filters are used to produce high density pulps containing as much as 25 per cent fiber such as is required by the recent development of high density bleaching. After bleaching the pulp may be effectively washed free from bleach liquors while it is still on the filters.

The salt industry has likewise recently been introduced to the continuous vacuum filter. Up to two years ago the industry was using centrifugal machines for the dewatering and partial drying of salt from the vacuum pans, or grainers. After a number of preliminary trials with a vacuum filter, the Oliver Continuous Filter Company was able to develop a machine of special design which satisfactorily handled crystalline substances. The mechanical details of this machine were described in *Chem. & Met.*, vol. 35, page 307, May, 1928.

With centrifugal operation, the salt crystals discharged had a moisture content in the neighborhood of 3.5 per cent. With the special filter developed for this work, the final moisture as discharged from the filter has been reduced to a point as low as 1.7 per cent for vacuum pan salt. This reduction in moisture has been obtained with a machine having only slow moving parts which have low maintenance and operating costs.

A further development of the same filter makes it available for use in dewatering ammonium sulphate as well as sodium nitrate, magnesium sulphate and other similar crystal substances. It is expected that the range of the machine will be widened to include a large number of other products of crystalline nature.

Air Separators Make Economical Fine Grinding and Classification Possible

By L. H. Sturtevant
President, Sturtevant Mill Company, Boston

BEFORE the day of air separators, it was necessary, in fine grinding, to pulverize to a finish within the mill. It followed that the mill could be fed only with that amount which could be finished within it. This resulted in cushioning of the grinding media and the regrinding of a large percentage of the material already fine enough before it had an opportunity to discharge. This, of course, gave a high cost of grinding, limited output, limited fineness, increased power consumption and caused great wear and tear on the equipment. The air separator has changed grinding methods materially, in fact, it might almost be said to have revolutionized them, for by grinding in closed circuit, using air separation, the separator and not the mill controls the finished product.

Thus, instead of trying to reduce the entire feed to the required fineness, the closed circuit method of grinding allows the mill to be fed with several times the amount of material that it can finish, so that the discharge may contain perhaps only 50 per cent of finished material. This, with the entire discharge of the mill, coarse and fine, passes over the air selector, the fines are removed to a predetermined mesh and the oversize is returned to the mill for regrinding. By the old method, a tube mill might have been fed with three tons per hour. Its hourly output would naturally be three tons. If, however, this same tube mill should be equipped with an air separator in closed circuit, and the feed be doubled to six tons per hour, while the mill was required to finish only 75 per cent of the amount of material passing through, the amount of finished product removed by the air separator would be 4½ tons per hour. If the feed should be further increased to nine tons per hour, and the mill again finished 75 per cent, its output would be 6¾ tons per hour and substantially the same power would be consumed as in the first example. At the same time there would be no more wear and tear. It can readily be seen that its output by the addition of the separator has been doubled.

Another application of air separators which is equally desirable is that in two stage reduction where a preliminary crusher precedes the pulverizer. For example, a hammer mill may be working in connection with a tube mill. The hammer mill is supposed in this instance to reduce to, we will say, 20 mesh for the tube mill, but in producing this 20 mesh, it makes about 60 per cent through 100 mesh. Assuming that 100 mesh is the finished product desired, there is obviously no advantage in feeding such material, already fine enough, to the tube mill. Therefore, by placing an air separator in closed circuit with both of these machines, the entire product of the hammer mill goes through the separator which extracts the 100 mesh finished material and returns the oversize to the tube mill, the product from which is also returned to the same separator where the fines are removed and the tails sent back to the tube mill. By this method, we make a gain of 60 per cent, representing the fines produced by the hammer mill, and we make another gain by the closed circuit practice of giving the tube mill all it can grind, up to its maximum efficiency.

Of course, an air separator need not be used solely in connection with grinding mills as it can work with any material from which the fines are to be removed, entirely independent of pulverizing. It may be used in series with screens to remove the finest products which cannot be produced economically by the latter, and thus allow the screens to work only on the coarser material with which screens may be used economically.

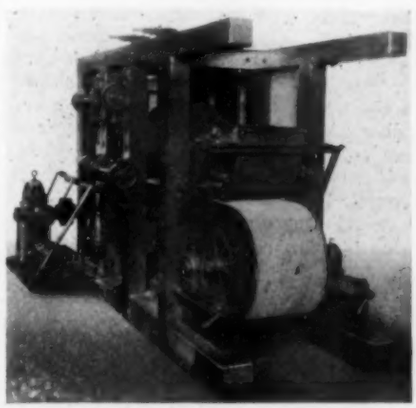
Air separators are being employed in a very wide variety of processes throughout the chemical engineering industries. They are being used in connection with hammer and tube mills on natural cement. Others are used with compartment mills for making supercement. Clay is being separated from silica. Calcined coke is being air separated. One firm is using an air separator in the difficult process of hydrating lime. Other separators are being used in connection with the refining of talc, the separating of burned lime and bone char. In general, wherever there is a fine separation problem with products even as fine as 300 to 350 mesh involved, air separators of one type or another present the logical solution.

Advances in Vacuum Filter Design

TWO VACUUM FILTERS of novel design have recently been developed. They are the Joubert and Goslin filter, and the Dorrco internal drum filter. The former is designed for especially heavy duty, and while externally in appearance it resembles a conventional drum filter, the internal arrangement is totally different. Instead of the usual port valve, vacuum is applied to the entire inner portion of the drum, excepting only a single section which is temporarily connected to air pressure through a large, sliding valve. This arrangement makes possible very large capacities with little resistance to the flow of filtrate.

The Dorrco filter is a radical departure from the ordinary, both in appearance and principle. The distinctive feature lies in the fact that the filter medium is applied on the inside of the filter drum, not only eliminating the conventional filter tank altogether, but permitting gravity to aid both in cake formation and cake discharge. One end of the drum is closed while at the open end there is provided an internal flange which acts as a dam to retain the pulp within the drum during filtration. Feed is admitted into the tank formed by the rotating drum where the action of gravity tends to segregate the coarser particles of the pulp against the lower filter sections which are under vacuum. Vacuum is applied in the usual manner by means of a rotary port valve, while the cake is discharged into a hopper within the drum by compressed air.

These two filters are illustrative of the present tendency toward the utilization of vacuum filtration wherever possible. This hinges upon the adaptability of vacuum filtration to continuous operation as distinguished from the semi-periodic nature of pressure filters. There are, however, many cases where the greater filtering pressure required or the necessity for such washing as can only be accomplished in pressure type filters make the use of the vacuum filter impossible.



Still Another Kind of Separator

An improved Dings magnetic separator of 60,000 ampère-turns adapted to the removing of magnetic particles from very large tonnages of product.

EVAPORATION

WHEN the early Egyptian engineer impounded an acre of sea water and let Old Sol make salt for him, he inaugurated an operation which has since witnessed much improvement, and yet is still used at times in its original form in competition with the best that modern practice can offer. Where climate prevents, however, and Old Sol can be made to assist only through the medium of coal, vacuum evaporation in single or multiple effect is the modern engineers's answer to the problem, for today's requirements make it necessary that the last available bit of work be forced from the reluctant B.t.u. Professor Badger tells below what recent years have demonstrated in the application of vacuum evaporation.

Efficient New Evaporator Types Result From Better Understanding of Heat Transfer

By W. L. Badger

Professor of Chemical Engineering, University of Michigan
Ann Arbor, Mich.

ACTUAL development of the modern evaporator occurred between the years 1860 and 1890. During these years a wide variety of designs were tried, and many modifications of the most important types were studied. By 1900 general practice had settled down to a relatively small number of types, the proportions of which were pretty well standardized. The ordinary vertical tube evaporator with either a central downtake or an annular downtake, the horizontal tube evaporator of the Wellner-Jelinek type and one or two of the film type evaporators were so well established that they seemed to fit most cases which arose in practice. During the period from 1890 to 1910 there was little change in standard evaporator construction. The considerable advances that have been made in the last fifteen years in our knowledge of the basic principles of heat transfer and the rapid development of the chemical industries in the United States have given fresh impetus to the study of evaporator design and the development of new types. The standard vertical and the Wellner-Jelinek horizontal are still widely used and meet many practical needs. It is becoming more apparent, however, that special designs for particular cases can be developed to the point where the added improvements are justified by either decreased first costs, improved quality of product, ease of operation, or freedom from repairs.

The Wellner-Jelinek horizontal evaporator is primarily adapted to free boiling, non-viscous, non-salting liquids, or to those cases where ease of tube renewal is an important factor. There has been no change in these machines or in their applications in recent years. There seems to be a tendency to favor the type with a body in the form of a vertical cylinder rather than the old Wellner-Jelinek construction which employed flat cast iron plates. This is largely a problem of fabrication and erection and has no relation to performance.

Everything which has been done to increase our knowledge of heat transfer in evaporators has laid increasing emphasis on the predominating effect of liquor velocity over all other factors which tend to increase capacity. Consequently, since the vertical tube evaporator is most suited to development along these lines, it is in this type that more of the developments are found.

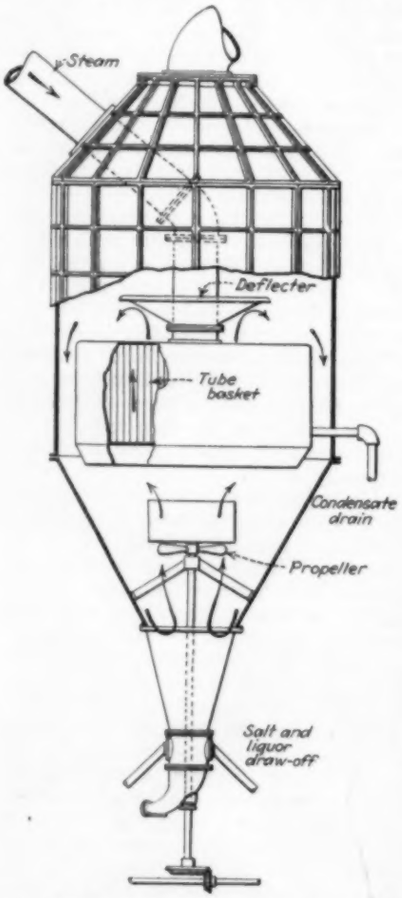


Fig. 1—Basket Type, Propeller Circulated Salt Evaporator

In the salt industry the standard vertical tube evaporator with a central downtake has been the standard type. It was early recognized that increasing the velocity of the liquid not only increased capacity, but what is much more important, delayed the accumulation of salt on the tubes and thus made it possible to run for longer periods between boil-outs. In the standard vertical, the propeller must be placed in the downtake and therefore develops a downward flowing stream of liquid directed into the cone. This results in an increased pressure which increases the circulation up through the tubes, but it also results in losses due to eddies and cross-currents so that much of the power which is applied to the propeller is lost. Recently, it has been suggested that the basket type vertical is much more suitable for this type of service, since in this case the propeller can be placed directly under the basket so as to drive the liquid upward into the tubes, thus minimizing losses due to cross-currents and eddies. Two very large evaporators of this type have been built, one a triple effect and one a quadruple effect. These have given highly satisfactory results, both as to rate of heat transfer and length of periods between boil-outs, without requiring as much power for the propeller as would be used in a standard machine of the same size. One of these machines is shown diagrammatically in Fig. 1.

Another recognition of the value of high speed in the liquid is the inclined tube evaporator of the Buffalo Foundry & Machine Co. This evaporator has been particularly successful in milk evaporation where the high velocities make it possible to concentrate milk with a minimum danger of deterioration from too long contact of the liquid with heating surfaces. It has also been possible to operate these machines on small enough temperature drops so that milk can be satisfactorily concentrated in double effect. This has not been possible with pans of previous designs.

The most direct recognition of primary importance of liquid velocity in promoting heat transfer in evaporators has been the development of the forced circulation evaporator by the Swenson Evaporator Company. In this case the tubes are made longer and narrower

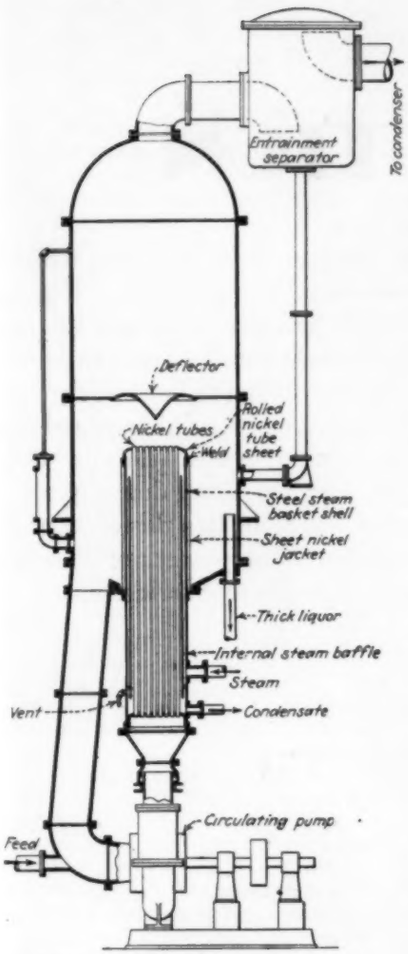


Fig. 2—Swenson Positive Forced Circulation Evaporator

than in the standard vertical, and the liquid is pumped through them at a high and positive velocity by means of an external pump. Most of the developments along this line have been in the caustic industry, where these machines are rapidly displacing standard verticals. Because of the high heat transfer coefficients, it is possible to decrease the heating surface to a point where it is practical to use nickel tubes. This entirely eliminates the expense and delays of replacing iron tubes that have failed from caustic embrittlement. It has made it possible to design an evaporator in which the caustic comes in contact with nothing but nickel or cast iron.

An additional advantage, however, is that due to the high heat transfer coefficient and also due to the fact that the velocity of the liquid is not dependent on the rate at which it boils. These evaporators may be used to concentrate cell liquors to 30 per cent caustic with triple effect operation. The 30 per cent liquor can then be concentrated to 42 per cent in a double effect, and 42 per cent liquor sent to a single effect. This has so greatly reduced steam consumption in some cases, as compared to the old arrangement of a double effect up to 40 per cent, that the evaporators have paid for themselves in less than a year.

This construction has also made it possible to design an evaporator for carrying caustic to high concentrations. Such a machine is illustrated in Fig. 2 and shows the essential features of the forced circulation evaporator. This machine is, at present, concentrating electrolytic caustic to 70 per cent NaOH with steam at 75 lb. gage. It is not possible to build the steam basket shell of cast iron for these pressures, but on the other hand it is highly undesirable to have plate steel in contact with high concentration caustic. Consequently, for these high concentrators the shell of the steam basket is made of steel with rolled nickel tube sheets. A jacket of rolled sheet nickle is welded to the top tube sheet and carried around the steam basket to a point below its joint with the vapor head. It has also been found desirable to add some nickel to the cast iron of which these machines are built.

A rather unexpected advantage of this machine is its freedom from entrainment. The mixture of steam and liquid which issues from the top of tubes strikes the curved deflector and is thrown downward and outward as a solid sheet of liquid traveling at high velocity. All of the vapors liberated from the liquid are liberated under this curtain, and in passing through the curtain are scrubbed entirely free from entrainment.

The ability of this evaporator to handle liquids of high viscosity is obvious. This has given it an advantage as a finishing pan for paper liquors, malt syrups, and other heavy liquids.

Another development of recent years is the flash evaporator for handling solutions of salts that have an inverted solubility curve. This was described by the writer in the *Transactions* of the American Institute of Chemical Engineers, Vol. 16, Part 2. This evaporator is in operation at present on anhydrous sodium sulfate, on sodium carbonate monohydrate, and on phenol still wastes, which are mainly sodium sulfate.

So far as general principles of evaporator operation are concerned there have been few changes. Pressure evaporators for sugar solutions are widely used in Europe, and have shown remarkable economies. They have not become popular in this country because a fundamental feature of the pressure evaporator is that it delivers vapor to the strike pans. Strike pans in this country are almost invariably designed for high pressure steam, and the introduction of the pressure evaporator as developed in Czechoslovakia would not be possible in this country without a very extensive revision of the evaporator and strike pan equipment. Thermocompression is much less heard of than formerly. A lowering of fuel costs in central Europe has removed one of the factors which made thermocompression practical there immediately after the war. There are practically no cases in this country where it has any marked advantages.

About the only important development in this country in evaporator operation is the tendency to use continuous removal of salt in salting evaporators. This is shown in Fig. 3 as a flow diagram. Instead of using two or more intermittent salt locks, or the elevators that at one time were so common on salt evaporators, present practice favors pumping a continuous stream from the bottom of the cone of a salting evaporator, sending this mixture to a settler, overflowing the clear liquid from the settler and returning it to the evaporator, and withdrawing the salt from the settler direct to centrifugals.

If the writer were to select a single feature to be noted as the principal advance in evaporation in the last ten years, it would, without question, be the increase in the number of technical men who appreciate the basic principles of heat transfer, and are therefore able to recommend, purchase, or operate heating and evaporating equipment on a rational basis.

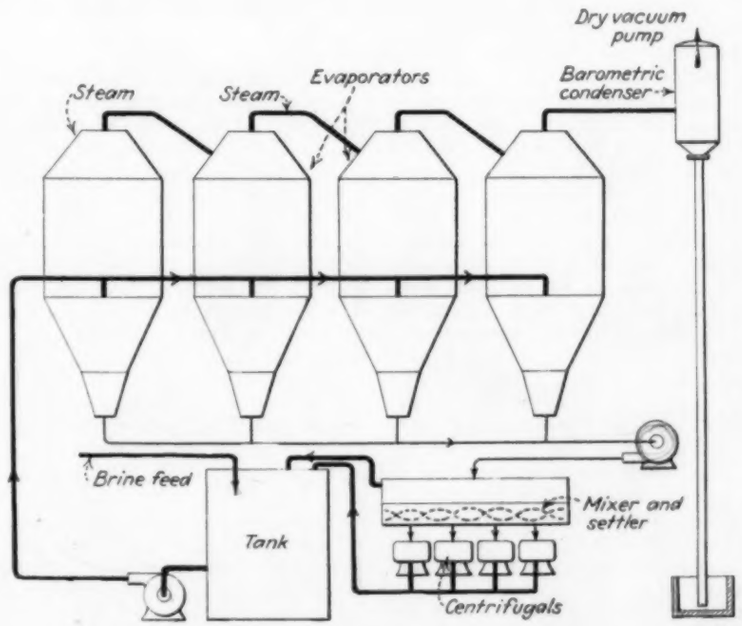


Fig. 3—Flow Diagram of the Continuous Removal, Salt Evaporation System

ABSORPTION *and* ADSORPTION

FOR MANY YEARS practice far outstripped theory in the field of absorption. Although the principles of counter-current flow and efficient contact had long been utilized, it was only with the recognition of absorption as a diffusional process that it became the subject of mathematical analysis. The application of the diffusion laws gave the first impetus to the theoretical studies that are now gradually giving us a truly scientific basis for designing more efficient absorption equipment. This progress is attested by the abundant literature on the theory of absorption which Professor Baker reviews in these pages. There is also a summary of practical advances in the gas industry—a fertile field for the application of the absorption process. Adsorption, closely related in theory, finds its most striking practical application through the activated carbons developed during the past ten or a dozen years. Some of the progress made in this direction and further opportunities for development are the subjects of two articles in the present series.

Rapid Progress Reported in Theory and Practice of Gas Absorption and Adsorption

By Edwin M. Baker

Department of Chemical Engineering, University of Michigan

DURING the past five years the unit process of gas absorption has been extensively studied. In its September, 1923 issue *Chem. & Met.* published a review of the unit processes of chemical engineering, which contained a brief article by the writer on the status of our knowledge at that time, and indicated that progress was being made at an increasing pace in the study of this unit process.

About this time W. G. Whitman *Chem. & Met.* Vol. 29, pages 146-8 (1923) presented a study of the rate of transfer of a gas between two phases, and advanced the "two-film theory." The work of the subsequent years has largely been devoted to the examination and extension of this theory, and to the determination of constants that are required to permit the use of the theory in engineering calculations. The two-film theory holds that the "gas film" and "liquid film" are the two principal resistances. In many cases the resistance of one film is so small in comparison to the other that it can be neglected without introducing any serious error. Haslam, Ryan and Weber *Ind. Eng. Chem.* Vol. 15, pages 1105-8 (1923) found that the coefficient for the gas film (reciprocal of resistance) varies as the 0.8 power of the velocity of the gas. The liquid film is independent of gas velocity. Hence, with increase of gas velocity, the overall absorption coefficient rises rapidly at first, but reaches an asymptote owing to the liquid film resistance.

The latter part of 1923 also saw the publication of a number of articles on equipment for gas absorption. Paul D. V. Manning *Chem. & Met.* Vol. 29, pages 504-5 described a tower packing material made of multiple helical coils of wire. T. C. Hageman in the same issue (pages 502-3) described the towers used by Norsk Hydro for the absorption of its dilute nitrous gases, and H. E. Fritz and J. R. Withrow *Trans. Am. Inst. Chem. Eng.* Vol. 15, I, reported tests made on special Vitreosil S- bends for the absorption of hydrochloric acid. Such equipment has since been quite widely used in the construction of hydrochloric acid plants in all parts of the country.

THE absorption symposium of the American Chemical Society, held in September, 1924, with W. G. Whitman as Chairman, resulted in the publication of a number of valuable contributions. (See *Ind. & Eng. Chem.* Vol. 16, pages 1215-38 (1924). Lewis and Whitman showed that the rate of gas absorption is controlled by the rate of diffusion through the surface films, and that the relative importance of the films is determined primarily by the gas solubility and to a lesser degree by the conditions of operation. With a highly soluble gas the resistance of the liquid film is negligible; with a slightly soluble gas such as oxygen the resistance of the liquid film controls, while for such gases as SO_2 both films may have to be taken into account. They also show that gas bubbles, which give constantly renewed liquid films, are particularly adapted to the absorption of the less soluble gases.

Haslam, Hershey and Keen working with an experimental tower of the wetted-wall type, determined the overall absorption coefficients for SO_2 and NH_3 over a range of gas velocities and temperatures.

P. G. Ledig, using a method developed by himself and Weaver *J. Am. Chem. Soc.* Vol. 46, page 650 (1924) reported a study of the rate of absorption of CO_2 into NaOH and KOH solutions. He found that the rate of absorption into KOH is almost twice that into NaOH.

Whitman and Davis studied the absorption of HCl, NH_3, SO_2 and oxygen through the surface of a liquid when the liquid is stirred. On the assumption that the specific diffusivities of various solutes through water are practically the same, and that the molecular diffusivities are also the same for these gases, they find that the absorption coefficients for sulphur dioxide, ammonia and hydrochloric acid can be predicted with an accuracy of 15 per cent or better. H. G. Becker studied the absorption of moderately soluble gases by stationary water, and presented a table of data on the initial rates of solution. F. W. Sperr, Jr. described the removal of hydrogen sulphide from artificial gas by scrubbing with dilute (1 to 3%) Na_2CO_3, and the subsequent regeneration of the sodium carbonate.

Williamson and Mathews studied the rate of absorption of carbon dioxide in alkaline solutions. They found the rate to be increased by increased turbulence of the liquid. The rate of solution of CO_2 in potassium carbonate solutions increased with rise of temperature up to about 70 deg. C., provided absorption was stopped when a saturation of 60 per cent was obtained.

In England Donald and Tyson *Chem. Trade J.* Vol. 73, pages 577-8 (1923) found that the overall coefficient of absorption in a tower depends on the density of the gas and is some function of the relative velocity between gas and liquid. In 1925 Kowalke, Hougen and Watson *Chem. & Met.* Vol. 32, pages 443-6 and 506-10 (1925) published two papers on

the absorption of ammonia in towers. Experimentally determined values of the absorption coefficient were in agreement with operating conditions in the gas industry. They advance the theory that the rate of absorption of NH_3 and similar gases is controlled by the diffusion factor, and a water distribution factor which is a function of the packing and the rates of water and gas flow. They state that the total surface of the tower packing is of less importance than the position of the surfaces and the best packing is that which produces the greatest agitation of the gas in direct contact with the water surface.

S. L. Tyler *Trans. Am. Inst. Chem. Eng.* Vol. 17, pages 75-9 (1925) described a new type of silica absorption vessel of the S-bend type, to be used in connection with small intermediate packed towers. The capacity of the system is given as 3 lb. of dry HCl per sq.ft. of liquid absorption surface per hour.

In 1926 C. H. Greenwalt *Ind. Eng. Chem.* Vol. 18, pages 1291-5 (1926) studying the absorption of water vapor by sulphuric acid, found that the absorption coefficient varied as the 0.4 power of the drop of pressure of the gas through the tower. Since the resistances of many tower packings to gas flow are known or are easily determined, this research facilitates the comparison of the effectiveness of tower packings.

WHITMAN, Long & Wang *Ind. Eng. Chem.* Vol. 18, pages 363-7 (1926) determined rates of absorption into a drop of water falling freely through gas. The coefficients were higher than for flat liquid surfaces, for bubbles rising through a liquid, or in wetted-wall columns. However, the ratio of gas film to liquid film coefficients was about the same. Whitman and Davis *Ind. Eng. Chem.* Vol. 18, pages 264-6 (1926) found that the absorption of CO_2 from a gas mixture by a solution of Na_2CO_3 and $NaHCO_3$ in a plate column could be adequately treated by the general absorption equation. The overall absorption coefficient was proportional to the 0.5 power of the gas velocity through the column. The same absorption equation governs the rate of rectification when steam and CO_2 are passed up through the lye solution. The coefficient for this rectification is, however, about 2.4 times as great as for absorption.

R. C. Cantelo *Chem. & Met.* Vol. 33, pages 680-1 (1926) developed a series of equations for continuous countercurrent absorption. Davis *Oil and Gas J.* Vol. 24, pages 50, 92, 121-2, 124 (1926) determined the vapor pressures of pure paraffin hydrocarbons in equilibrium with pure hydrocarbons as absorbents, and discussed the properties of an ideal absorption oil.

In 1927 Cantelo, Simmons, Giles and Brill *Ind. Eng. Chem.* Vol. 19, 989-92 (1927) studied the absorption of CO_2 and SO_2 in a tower, and reported that the solution coefficient is independent of gas velocity and composition of gas, but does vary as the first power of the rate of flow of absorbing liquid. Krase and Hetherington *Ind. Eng. Chem.* Vol. 19, pages 208-11 (1927) found that solutions of $(NH_4)_2CO_3$ containing NH_4NO_3 have partial pressures of CO_2 considerably higher than solutions free from NH_4NO_3; and outline a process, based on this fact, for removing of CO_2 from gas mixtures and recovering it in a relatively pure state.

C. Toniolo *Chem. & Met.* Vol. 34, pages 92-5 (1927) pointed out the beneficial effect of cooling the acid circulating towers designed for the recovery of nitrogen oxides, from the oxidation of ammonia, as nitric acid. He presented performance curves and descriptions of some foreign plants. R. Riou *Compt. Rend.* Vol. 184, pages 195-7 (1927) described an apparatus for investigating gas absorption, in which the amount of gas absorbed is measured automatically by aspirating water into the absorption chamber, at a rate equal to the rate of gas absorption. Bodewig *Z. ges. Schiess-Springstoffw.* Vol. 22, pages 166-9 (1927) discussed the recovery of volatile solvent vapors from air in plants making such products as smokeless powder. He found refrigeration alone to be inefficient, and recommends as an absorbent the cresols advocated by Bregeat. U. S. Patent 1,558,336 (Oct. 2, 1925.)

The most notable contribution to the theory of gas absorption in 1928 is that of Lewis and McAdams *Ind. Eng. Chem.* Vol. 20, pages 253-57 (1928); and Walker, Lewis, and McAdams, "Principles of Chemical Engineering." 2nd Ed. New York. These authors present graphical methods of design, based on accepted theories, which are generally applicable. These graphical methods not only lessen the labor of computation, but they also make possible the correct solution when the curve expressing the equilibrium concentrations in the gas and liquid phases is of irregular shape. In the latter respect, the authors have advanced to new grounds the theoretical treatment of gas absorption problems. Continuing with this work, Lewis *Chem. & Met.* Vol. 35, pages 93-5 (1928) has applied the graphical methods to the design of natural gas gasoline absorbers, and was able satisfactorily to calculate the absorption of each of the several hydrocarbons involved.

J. W. H. Monaweck, in a Ph.D. thesis, Univ. of Mich., to be published, has recently investigated the mechanism by which the gas and liquid films are built up, by observing the rate of absorption which takes place, starting from the instant that gas and liquid phases are brought into contact.

IT WOULD APPEAR that the past five years have seen considerable additions to our knowledge of the mechanism of gas absorption, and to our ability more closely to design equipment for gas absorption. As in most cases where the art has been more advanced than theory, marked changes in equipment for commercial work would not be expected, and have not taken place. During this period, however, a portion of the field of gas absorption has been invaded by equipment for accomplishing more efficiently the same ends by gas adsorption. The applications to which the advocates of adsorption have devoted most effort seem to be the recovery of oxides of nitrogen from the arc process or from the oxidation of ammonia, the recovery of solvents such as benzene and toluene from artificial gas, and the recovery of the gasoline occurring in natural gas.

Adsorption from Liquid Phase Used in Many Manufacturing Operations

By L. M. Gill
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ADSORPTION is the change of concentration at the interface of phases. As applied to activated carbons the interface is at the surface of the carbon and the change of concentration is utilized practically for purposes of purification in the removal or separation of dissolved substances or colloidal suspensions of solids in liquids.

Although wood charcoal and bone char have been in use as purifying agents for many decades little was known about the mechanism of adsorption until about ten years ago. The work done during and after the war on the development of a highly activated char for gas masks gave an indication of the possibilities of activated carbons for industrial purposes. The basic principles of the activating process are the same for carbons for adsorption from the gaseous phase as for carbons to be used in liquids, but the two carbons cannot be expected to work interchangeably.

Much progress has been made in the direction of increasing adsorptive power per unit of cost. For this reason adsorption with decolorizing carbons in the liquid phase is coming more and more into favor as a means of lowering production costs. The use of highly activated decolorizing carbons has shown marked savings over older methods of purification. In addition, in many instances it has thus been possible to purify liquids and solutions that did not react to other methods of treatment.

AS AN EXAMPLE of the improvement of a process by using activated carbon, the recovery of solvent in dry cleaning plants may be cited. Formerly it was necessary to distill large volumes of solvent to restore its original cleaning qualities. Distillation has now

been largely superseded by treatment with activated carbon resulting in a decided saving to the industry. This application of adsorption points out two advantages, first a saving in cost of operation and second a means of obtaining a product more perfectly suited to the purpose in hand.

Adsorption with activated carbon is most extensively used in industries where impurities in the form of coloring matter are to be removed from liquids. The vegetable-oil industry producing both edible and inedible products, is dependent on a method of close control for standardizing the color of its finished articles—lard compound, salad and cooking oils, and paint oils. Fullers earth was formerly used exclusively, but activated carbons have shown the way to many economies of operation. The sugar and syrup industries have also been benefited by the application of activated carbons. In the refining of sugar recent developments indicate that the day is not far distant when the expensive and elaborate layout required for bone char will have become obsolete.

ACTIVATED CARBONS are not confined to color removal only. A zinc sulphate manufacturer was faced with several complaints about odor in the finished product although it met specifications as far as color and other tests were concerned. It developed that the odor was caused by a trace of hydrogen sulphide remaining even after recrystallization and thorough washing. A treatment of the zinc sulphate liquor with a small quantity of activated carbon solved the problem quite satisfactorily and no further odor troubles were encountered. No extra step was added to the process since it was necessary that the liquor be filtered for separation of suspended solids and the carbon could be conveniently added along with the filter aid.

Recent developments in counter-current methods have demonstrated a further saving in carbon costs. In the two-stage counter-current process, the once-used carbon is mixed with the untreated liquid while the once-treated liquid comes in contact with new carbon. An extra filtration is necessary but in spite of this, two uses of the carbon are still profitable in the majority of cases.

In selecting a carbon for a given problem four points should be borne in mind, first, its adsorbent power per unit cost, second its capacity to permit rapid filtration, third its freedom from soluble compounds that may contaminate the liquid being treated, and fourth its density. This last point determines the relative amount of material that must unavoidably be lost in the spent carbon filter cake.

There are doubtless scores of applications for decolorizing carbons in the process industries today, but comparatively recent development of these products has prevented their properties and advantages from becoming widely known. Any manufacturing operation employing crystallization, distillation, or chemical processes for the elimination of color or other impurities represents a possible application. Unfortunately there are still the remnants of the old tendency to regard many uses of adsorption with carbons as secret processes to be carefully guarded rather than shared with other industries. This has contributed much to the slow development of the art. It is hoped that the time is not remote when adsorption will be as well known as other unit processes and accepted on an equal plane with them.

Absorption Processes in the Gas Industry Have Many Applications

By E. C. Uhlig

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REMOVAL of hydrogen sulphide from gas by means of a solution of sodium carbonate is a development of recent years and while successful in its primary object further work is being done to make it profitable principally with the object of obtaining a revenue from the recovered sulphur. Gas is brought into contact with a solution of Na_2CO_3 and the hydrogen sulphide is removed with the formation of $NaHCO_3$ and NaHS. Other impurities such as cyanides are also removed. In the original process the fouled alkaline solution is reactivated by a current of air, the H_2S being liberated and passed to the atmosphere, and the alkaline liquor made capable for use again in gas purification. A recent development is the liberation of the sulphur as a sludge from the fouled solution by catalytic oxidation using nickel, iron or other catalysts. While this sulphur is not expected to compete as such with Gulf-coast sulphur for chemical industry, it possesses peculiar properties that make it very effective as an insecticide and fungicide in agriculture and horticulture. Recovered sulphur is now being produced on a commercial scale in California. (See *Chem. & Met.*, Vol. 35, No. 7, page 407.)

REMOVAL of naphthalene from gas is accomplished by means of scrubbing with tar or oil in various types of absorption apparatus and improvements have been directed toward increasing the efficiency of the processes by improving the contact between the gas and scrubbing liquid so that the volume of liquid and the naphthalene content of the scrubbed gas may both be kept at a minimum. The two outstanding recent developments are the vertical Feld type scrubber developed by the Bartlett Hayward Company and the tower system of the Koppers Company. The equipments used in both systems occupy very little ground space.

In the Feld apparatus the gas in its upward passage through the scrubber is forced to pass successively through several layers of spray formed of the liquid thrown off by centrifugal force from revolving cones attached to a vertical shaft in the center. The liquid collects in a tray under each cone and drains from one compartment to the next and a counter-current movement of the liquid is obtained which insures scrubbing with a minimum of oil.

The Koppers Company scrubber makes use of a two-section tower filled with a special packing to insure an intimate contact between the gas and liquid with very little back pressure. Gas enters the scrubber near the base and passes counter current to the oil flow, first through the primary or recirculating oil section, next through the secondary or fresh oil section and finally through the outlet.

Since only a small amount of oil is necessary or desirable, the fresh oil is not pumped into the scrubber tower continuously, but is injected periodically at a high rate of flow, thereby securing good distribution and good scrubbing efficiency.

LIGHT-OIL recovery has been improved by two recent developments consisting in the use of silica gel and activated carbon. The object of using silica gel is to remove gum-forming and unstable compounds from the light oil which has been recovered from the gas and producing by subsequent distillation a water-white motor benzol. Oil is treated with gel by percolation at approximately 300 deg. F. and 50 lb. per sq.in. pressure at a ratio of 25 parts of oil to 1 part of gel. This ratio has been also increased to 200 to 1. The crude light oil from a storage tank is acidulated with about 0.3 per cent by weight of 95 per cent H_2SO_4 and the sludge settled out. The oil freed from sludge is then forced through a heat exchanger into a percolator containing a charge of silica gel from a storage hopper. It passes up through the gel in the percolator emerging at the top as clear oil. After passing through the heat exchanger and a cooler it enters a neutralizer containing a caustic alkaline solution through which it bubbles and the small amount of remaining acid is removed. It then goes to a treated oil storage tank from which it is taken to a still for recovery of the first cut or motor benzol. The distillate is washed with water to remove any traces of acid and the benzol decanted from the water.

The gel in the percolator is considered spent when the sample of the oil shows on distillation and proper cutting a Saybolt color below a specified standard. At the end of the treating period the gel passes into a decanting hopper and the oil which accompanies it drawn off. The gel is then heated by a steam jacket and the greater portion of the oil in the

pores driven off and passed through a condenser and collected in a storage tank. Live steam passed through the gel aids in the expulsion of the oil. The decanted oil and condensed oil is returned to an agitator above the percolator where it is used as a vehicle for transferring the gel from the storage hopper to the percolator.

The gel then goes at a uniform rate to a primary and secondary activator, where in the former the remaining oil is removed and later condensed and in the latter the heavy ends and carbonaceous matter are burned out with heat from a gas furnace. The purified gel is then carried by an air current to the storage hopper for further use. The Rochester silica gel light-oil treating plant has recently been described by R. E. Kruger. (*Gas-Age Record*, April 28, 1928, page 577.)

USE of activated carbon for the recovery of light oils from gas is reported from Germany. In this process the gas is first scrubbed to remove tar, ammonia and cyanogen compounds and is then passed through a series of absorbers containing activated carbon. At the beginning of the adsorption, the first adsorber takes up all the condensible vapors and gases, but eventually the ethylene is replaced by benzene and its homologs, which are recovered by distillation with steam. The gases from the first adsorber are mixed with a small amount of air and passed to the second adsorber, in which the sulphur is deposited by the catalytic action of active carbon upon hydrogen sulphide and oxygen. The sulphur may be removed by suitable solvents. It is stated that the process works quite simply without mechanism of any kind and is easy of supervision.

DEHYDRATION of gas, since the water carried by gas is the principal agent in producing corrosion in distribution systems, has stimulated efforts toward the removal of at least a portion of this water. The efforts made have had the object of reducing the dewpoint of the gas to a temperature below that which it will encounter in the distribution system. Several methods are being experimented with and the one which is attaining commercial proportions is that of scrubbing the gas with a solution of calcium chloride.

This is being carried on by some British gas companies and several descriptions have appeared recently of the dehydration plant of the Taunton gas works. (See articles in *Gas-Age Record* by G. A. Bragg, E. F. Coffman, T. K. Cleveland and W. H. Fulweiler, Feb. 4-June 2, 1928.) The gas is scrubbed with a strong solution of calcium chloride in a Holmes rotary washer. The absorption of the moisture from the gas results in the heating and dilution of the calcium chloride solution. Cooling coils maintain the circulating solution at a constant temperature and a portion of it is continuously directed from the circulating system and evaporated to remove the water absorbed from the gas, thus maintaining the solution at a constant strength. The costs of dehydration per thousand feet of gas are between 0.46 cent and 0.92 cent, varying with the manufacturing capacity of the plant.

Modern Purification Methods Using Activated Carbon

By Bernard N. Glick
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TO THE general public, the color of a product is still the indicator of its purity and, even from the technical viewpoint, it is curious to realize how widely this generalization holds true and how many products we strive to make as nearly colorless as possible. This insistence on whiteness as a badge of purity has led to an enormous expansion in the use of decolorizing carbons.

Up to twenty years ago and even up to ten years ago, the usual decolorization and purification methods in vogue involved either: 1. A chemical bleaching of the colored impurities in solution. 2. Distillation of liquids. 3. Recrystallization of solids.

Chemical bleaching usually entails the use of either an oxidizing or reducing agent and leaves the bleached impurity and any excess of the reagent still present in the liquor treated. Such a process has obvious disadvantages, for while it has improved the appearance of the product it has really impaired the actual purity of the liquor.

Distillation, while satisfactory as far as purity of the finished product is concerned, is limited in its application, expensive in operation, and entails losses owing to the fact that in order to ensure complete retention of the impurities in the still, varying amounts of the product must be left in the undistilled residue. Recrystallization is also limited if losses in the mother liquors are to be avoided. Small amounts of coloring matter in the original liquor are apt to be carried down by the recrystallized solids.

ACTIVATED carbons, owing to affinity for absorbing coloring matter and other dissolved impurities from a liquor treated with them, have in many instances practically eliminated the necessity for other purification processes. Their use is extremely simple. The liquor to be treated is mixed thoroughly with an amount of carbon determined by previous laboratory test, the mass brought up to the most suitable temperature and agitation maintained for about 15 to 30 minutes. The carbon is then removed from the treated liquor by simple filtration.

Chemical bleaching, as formerly used in the treatment of various acid solutions like phosphoric, citric and tartaric, has been practically eliminated, especially when the resulting solutions are for the manufacture of food products. Decolorizing carbons have become standardized in this industry.

In the preparation of C. P. glycerine it was formerly necessary to start with a fairly good crude, treat it exhaustively, and then distill repeatedly to get the colorless product of high purity demanded by medical and manufacturing requirements. By the use of decolorizing carbons practically any grade of crude can be handled, and while distillation has not been entirely dispensed with, the necessity for it has been very materially reduced, resulting in higher recoveries and large economies.

Savings brought about by the elimination of recrystallization have been demonstrated in the manufacture of comparatively expensive chemicals like the alkaloids, photographic compounds, and certain pharmaceuticals. There are few modern plants where the solutions of these products are not decolorized as completely as possible before crystallization by the use of decolorizing carbons. Even inexpensive products like borax and epsom salts solutions are being treated economically.

IMPROVEMENT in appearance of hitherto finished articles of manufacture has sometimes resulted in increased salability and higher prices. For example the manufacture of gelatine would result in the production of a certain grade of material which no previous procedure could improve. Using activated carbon, however, in the manufacturing operation, results in the production of a distinctly higher grade product, at a cost that makes its production commercially desirable.

Among other new developments in the use of decolorizing carbon is its application in the recovery of products formerly thrown away as of no further value. In preserving and canning, fruits are boiled with mixed syrups containing sucrose and glucose and in the successive uses of these syrups their color and general purity becomes so lowered, that finally they reach a stage where their further use would impair the quality of any fruits treated with them. At this stage they were formerly discarded in spite of their valuable sugar content, but now it requires only a very simple treatment with activated carbon to bring them back to their former appearance and purity and render them capable of further use.

Thus it will be observed that decolorizing carbons have brought about extensive economies and improvements in various lines of industry. A purification problem that seems to be unusually difficult or expensive can often be cheaply and efficiently solved by the use of one of these carbons.

PATENTS ISSUED

Aug. 7 to Aug. 28, 1928

PAPER, PULP, GLASS AND SUGAR

Process of Manufacturing Pulp for Paper Production. Dinshaw Rattonji Nanji, Birchfield, Birmingham, England.—1,679,441.

Soda-Ash Furnace. Dwight R. Means, Medina County, Ohio, assignor to Pittsburgh Plate Glass Company.—1,679,486.

Paper-Making Machinery. Ralph E. Heisel, Chillicothe, Ohio, assignor, by mesne assignments, to Paper Machinery Corporation, Dayton, Ohio—Limiting lateral spread of pulp.—1,679,523.

Method of Pulping Wood. Francis G. Rawling, Knoxville, Tenn.—1,679,682.

Deinking Paper. Alan R. Lukens, Wyoming, Ohio, assignor to The Richardson Company, Cincinnati, Ohio.—1,680,949.

Method of Collecting Inorganic Potassium Salt, Betain Salt, and Glutamic Acid from the Waste Liquor Produced in Distilling Alcohol from Fermented Beet Molasses. Yoshitaro Takayama, Koishikawa Ku, Tokyo, Japan, assignor to Saburosuke Suzuki, Tokyo, Japan.—1,681,379.

RUBBER, RAYON AND SYNTHETIC PLASTICS

Art of Vulcanizing Rubber. Lorin B. Sebrell, Akron, Ohio, assignor to The Goodyear Tire & Rubber Company, Akron, Ohio.—1,679,548.

Process for Reducing the Viscosity Characteristics of Cellulose Ethers and Products Thereof. Chauncey U. Prachel and Leonard E. Branchen, Rochester, N. Y., assignors to Eastman Kodak Company, Rochester, N. Y.—1,679,943.

Process of Making Cellulose Acetate. Edward S. Farrow, Jr., Rochester, N. Y., assignor to Eastman Kodak Company, Rochester, N. Y.—1,679,966.

Manufacture of New Cellulose Derivatives. Leon Lilienfeld, Vienna, Austria.—1,680,224.

Plastic Material. William Burton Wescott, Boston, Mass., assignor to Rubber Latex Research Corporation, Boston, Mass.—1,680,234.

Methods of Treating Rubber Latex. Sidney M. Cadwell, Leonia, N. J., assignor to The Naugatuck Chemical Company, Naugatuck, Conn.—1,680,856-8.

Purifying Phenolaldehyde Resins. Fritz Seebach, Erkner, near Berlin, Germany, assignor to Bakelite Gesellschaft m. b. H., Erkner, near Berlin, Germany.—1,681,368-9.

Method of Removing and Recovering Volatile Plasticizers from Celluloid, and the Like. Harry P. Bassett, Cynthiana, Ky.—1,681,692.

Vulcanization of Rubber. Ralph V. Heuser, Burrage, Mass., assignor, by mesne assignments, to Albert C. Burrage, Jr., Ipswich, Mass.—1,681,806.

Cellulose-Xanthating Process. William Mendel, Beverly, N. J., assignor to Samuel A. Neidich, Edgewater Park, N. J.—1,681,900.

Cellulose Derivative and Process for Producing Same. Leon Lilienfeld, Vienna, Austria.—1,682,292.

Sulphonated-Cellulose Derivatives and Process of Preparing Them. Georg Kränzlein, Arthur Voss, and Franz Brunnträger, Hochst-on-the-Main, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main.—1,682,382.

Manufacture of Condensation Products Containing Sulphur. Oskar Spengler and Alfred Thurm, Dessau in Anhalt, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.—1,682,434.

PETROLEUM REFINING AND EQUIPMENT

Oil-Refining Still. Orrin E. Andrus and Sune Hermanson, Milwaukee, Wis., assignors to A. O. Smith Corporation, Milwaukee, Wis.—1,680,276.

Apparatus for the Fractional Extraction of Petroleum Hydrocarbons With Alcohol. Theodore A. Werkenthin, Lima, Ohio, assignor to The Solar Refining Company, Lima, Ohio.—1,680,353.

Fractional Distillation. Joseph W. Lewis, Jr., Philadelphia, Pa., assignor to The Atlantic Refining Company, Philadelphia, Pa.—1,680,421.

Method of Preparing Artificial Petroleum from Rubber Scrap or Vulcanized-Rubber Waste. Hirotaro Nishida and Kelichi Shimada, Kiriu, Japan.—1,680,908.

Process and Apparatus for Treating Oil. David G. Brandt, Westfield, N. J., assignor to Doherty Research Company, New York, N. Y.—1,681,321.

Refining Hydrocarbon Oils. Hiram J. Halle, New York, N. Y., assignor to Universal Oil Products Company, Chicago, Ill.—1,681,638.

Apparatus for Converting Hydrocarbon Oils. Oswald C. Brewster, Casper, Wyo., assignor to Standard Oil Company, Whiting, Ind.—1,681,658.

Method of Generating Gas. Claude W. Botsford, Los Angeles, Calif., assignor to William W. Odell, Pittsburgh, Pa.—1,682,264.

Process of and Apparatus for Distillation of Oil from Oil Shale. Herman B. Kipper, Muskegon, Mich.—1,682,287.

Method of Disposing of Acid Sludge and Spent Clay in Oil-Refining Plants. James M. Cory and Fred H. Bunke, Lima, Ohio, assignors to The Solar Refining Company, Lima, Ohio.—1,682,369.

Liquid Phase Purification of Distillates. Thomas G. Delbridge and Joseph Bennett Hill, Philadelphia, Pa., assignors to The Atlantic Refining Company, Philadelphia, Pa.—1,682,603.

COAL PROCESSING AND COMBUSTION

Gas Producer. George Herbert Bentley and Edmund Gardner Appleby, Westminster, London, England; Geoffrey Edmund Appleby and William Wallace Hargrove, executors of said Edmund Gardner Appleby, deceased, assignors to said Bentley.—1,679,645.

Plastic Material from Peat and Process of Producing. Isadore Sidney Mellanoff, Philadelphia, Pa., assignor to Kemikal, Inc., Philadelphia, Pa.—1,681,155.

Apparatus for the Manufacture of Mixed Gas. Morris William Travers, London, and Frank William Clark, Lyman, England, assignors to Regenerative Coal Gasification System, Limited, Manchester, England.—1,681,313.

Stable Suspension and Paste of Coal. Robert Griessbach and Julius Eisele, Ludwigshafen-on-the-Rhine, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main.—1,681,335.

Low-Temperature Fuel Distillation. Edmund George Weeks, Dunston, England, assignor of one-half to the Firm Merz & McLellan, Engineers, Westminster, London, England.—1,681,450.

ORGANIC PROCESSES

Making Formaldehyde from Methylene Chloride. Erich Krause and Koloman Roka, Constance, Germany, assignors to the Firm of Holzverkohlungs-Industrie Aktien-Gesellschaft, Constance, Baden, Germany.—1,679,673.

Finely - Divided Nitroguanidine and Method of Making Same. Arthur P. Tanberg and Richard L. Kramer, Wilmington, Del., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,679,752.

Manufacture of Acetic Acid and Acetates. Philip Arthur Smith, London, and Harold Greville Smith, Stockton-on-Tees, England, assignors to Synthetic Ammonia & Nitrates Limited, Billingham, Stockton-on-Tees, England.—1,679,994.

Process for Producing Hydrocyanic Acid. Mortimer Jay Brown, Niagara Falls, and Earle Atherton Harding, La Salle, N. Y., assignors to Roessler & Hasslacher Chemical Company, New York, N. Y.—1,680,662.

Method of Treating Partial Oxidation Products. Joseph Hidy James, Pittsburgh, Pa., assignor to Clarence P. Byrnes, trustee, Sewickley, Pa.—1,681,185.

Process of Producing Acetic Acid. Francis George Rawling, Madison, Wis.—1,681,684.

Synthesis of Organic Compounds. Henry Herman Storch, New York, N. Y., assignor to The Roessler & Hasslacher Chemical Company, New York,—1,681,750-3.

Manufacture of Hydroxy-Acid Esters. Howard W. Matheson, Montreal, Quebec, and Kenneth G. Blaikie, Shawinigan Falls, Quebec, Canada, assignors to Canadian Electro Products Company, Limited, Montreal, Canada.—1,682,347.

Apparatus for Producing Carbon. Chauncey Matlock, Brooklyn, N. Y., assignor to Monroe-Louisiana Carbon Company, Monroe, La.—1,681,945.

INORGANIC PROCESSES

Method of Making Aluminum Sulphate. Roy Mackay Meiklejohn, Flushing, N. Y., assignor to General Chemical Company, New York.—1,679,366.

Process of Removing Ammonia from Synthesis Gases. Roland Edgar Slade, Billingham-on-Tees, and Kenneth Gordon, Stockton-on-Tees, England, assignors to Atmospheric Nitrogen Corporation, Solvay, N. Y.—1,679,792.

Apparatus for the Formation of Nitric Acid or Hydrochloric Acid. Giuseppe Guadagni, Turin, Italy.—1,680,019.

Process for Obtaining Pure Alumina and Alkali-Metal Carbonates. Fritz Rothe, Aachen ,and Hans Brenek, Porz, near Cologne, Germany, assignors to the Firm Rhenania Verein Chemischer Fabriken A. G., Cologne, Germany.—1,680,066.

Purification of Naphthalene. Georg Schroeter, Berlin, Germany.—1,680,070.

Composite Titanium Pigment and Method of Making Same. Louis E. Barton and Lonnie W. Ryan, Niagara Falls, N. Y., assignors to Titanium Pigment Company, Inc., New York, N. Y.—1,680,316.

Process of Producing Phosphoric Acid. Hermann Lang, Bitterfeld, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort.—1,680,625.

Process for Refining Crude Arsenic Trioxide. Chester L. Read, Rahway, N. J., assignor to American Smelting and Refining Company, New York, N. Y.—1,681,496.

Process for Purifying Sodium Stannate Solution. Chester L. Read, Rahway, and Berry Marvel O'Harra, Westfield, N. J., assignors to American Smelting and Refining Company, New York, N. Y.—1,681,497.

Apparatus for the Manufacture of Sodium Sulphide and Hydrochloric Acid. Emanuel V. Benjamin, New Orleans, La., assignor to Myles Salt Company, Limited, New Orleans, La.—1,681,760.

Gels and Method of Preparing the Same. Walter A. Patrick, Baltimore, Md., assignor to The Silica Gel Corporation, Baltimore, Md.—1,682,239-42.

Process for the Production of Primary Stibinic Acids. Fitzgerald Dunning and Ebenezer Emmet Reid, Baltimore, Md., assignors to Hynson, Westcott & Dunning, Baltimore, Md.—1,682,269.

CHEMICAL ENGINEERING PROCESSES AND EQUIPMENT

Fluid-Treating Apparatus. William A. Pownall, Decatur, Ill.—1,679,373.

Apparatus for Feeding and Metering Pulverulent or Granular Materials. Ervin G. Bailey, Cleveland Heights, Ohio, assignor, by mesne assignments, to Fuller Lehigh Company.—1,679,557.

Device for the Cooling of Fatty Emulsions or the Like. Wilhelm Gotthilf Schröder, Arfrade, near Lubeck, Germany.—1,679,685.

Process for Purifying Gases. Walter H. Fulweiler, Wallingford, Pa., assignor to The U. G. I. Contracting Company, Philadelphia, Pa.—1,679,858.

Preparation of Yeast, Gustaf Olof Wolfgang Heijkenskjöld, Stockholm, Sweden, assignor to Aktiebolaget Bästa, Stockholm, Sweden.—1,680,043.

Drying Apparatus. Frank L. Allen, Montclair, N. J., and Arthur D. Flower, Wilmington, Del., assignors to Edge Moor Iron Company, Edge Moor, Del.—1,680,274.

Diffusion Plate. Lorenzo S. Washburn, Worcester, Mass., assignor to Norton Company, Worcester, Mass.—1,681,890.

Heat Transfer. John E. Bell, Brooklyn, N. Y., assignor to Foster Wheeler Corporation, New York, N. Y.—1,681,926.

Process for Forming Ceramic Ware. Halver R. Straight, Adel, Iowa.—1,682,200.

Process and Device for Concentrating Incrusting or Corrosive Solutions. Plinio Bringhenti, Milan, Italy.—1,682,265.

Production of Dry Gases. Gustav Wietzel and Fritz Stoewener, Ludwigshafen-on-the-Rhine, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.—1,682,588.

Refractory Heat-Insulating Material and Method of Making the Same. Basil T. Horsfield, Badin, N. C., assignor to Aluminum Company of America, Pittsburgh, Pa.—1,682,675.

NEWS

OF THE INDUSTRY

Sodium Silicofluoride Duty on Higher Level

BY PROCLAMATION of the President, issued August 31, the import duty on sodium silicofluoride was increased by changing the basis of the ad valorem duty of 25 per cent from the foreign market value to the American selling price. The increases in duties were asked by the Oconee Alkali Company, Athens, Ga., and the Southern Alkali & Chemical Company, Savannah, Ga. Upon the application of these two concerns, the Commission instituted a cost-of-production investigation in this country and abroad on July 24, 1925. After a careful examination of foreign cost data, the Commission found the product was imported chiefly from Denmark and Holland. The Commission revealed that production costs in this country exceeded those of the two countries named.

Under section 315 of the tariff act of 1922, the President has power to increase duties by 50 per cent when necessary to equalize domestic and foreign production costs, but where this increase is still not sufficient to offset the differences in costs the President is authorized to change the basis of ad valorem duties from foreign value to domestic selling price of comparable American articles, as was done in this case.

Russia Plans for Enlarged Dye Production

AN AGREEMENT has just been concluded between the Amtorg Trading Corporation, acting in behalf of the Aniltrest (Aniline Trust) of the U.S.S.R. and Prof. Harry D. Gibbs of Washington, D. C., according to an announcement made by M. G. Gurevitch, acting chairman of the board of directors of the Amtorg Trading Corporation, calling for the technical assistance of Professor Gibbs in the organization of the production in the Soviet Union of a series of chemical products used in the aniline industry. The purchase of the equipment required for these plants will be made in the United States.

The aniline dye industry of the U.S.S.R., which was practically nonexistent before the war, has made rapid strides in the past few years. The development of the coke-benzol industry in the Donetz and Kuznetz Basins has laid the groundwork for the building up of the aniline industry. In the past two years an annual average of over 8,000 tons of organic dyes was produced in the Soviet Union. Nevertheless the industry is as yet in the infant stage and a large part of the requirements is still imported.

It is expected that Professors Rodionov and Vorozhtzov of the Aniltrest will visit the United States in the near future to confer with Professor Gibbs on matters connected with the present agreement.

Chile Resumes Centralized Sales of Nitrate

CENTRALIZED sales of sodium nitrate have been resumed in Chile and prices for the United States have been fixed, the Department of Commerce was advised August 29 in cabled reports from the American commercial attache at Santiago. The report stated that nitrate selling by the Nitrate Producers' Association has been started again and the resumption introduced another era of centralized selling at fixed prices. The producers have agreed to quote nitrate prices f.a.s. nitrate ports for the United States and countries other than those of Europe and of Mediterranean ports, increasing from 16s. 3d. in September to 16s. 7d. in March, 1929, the latter price to remain stationary throughout June.

Nitrate shipments to European and Mediterranean ports are to be delivered through the customhouses at sellers' risk and at different prices for each country. As a result of the discussion regarding these arrangements, nitrate sales during August were very slow.

Electrochemists Will Meet in Charleston

A VERY attractive technical program has been arranged for the Fall meeting of the American Electrochemical Society which will be held at the Hotel Kanawha, Charleston, W. Va., September 20-22.

Thursday morning, September 20, there will be a discussion on chemical reactions at 1,000 deg. and above. The Friday morning session will include a paper on the corrosion of the tin can; another one, on the electrochemistry of the proteins; one, on the Weston standard cell, and a half dozen others. The Saturday morning session will, as usual, be devoted to electrodeposition. Prof. F. C. Mathers, of the University of Indiana, will discuss the electrodeposition of tellurium. Another paper reports on the co-deposition of copper and graphite. There will also be a paper on a new method of nickel plating and several papers on chromium plating.

Swampscott Meeting of A.C.S. Largely Attended

MORE THAN two thousand chemists were the guests of the Northeastern Section of the American Chemical Society at the seventy-sixth meeting of the national organization, which was held at Swampscott, Mass., September 10 to 14. Because of the famous natural attractions of the North Shore resorts and the popular interest in historic scenes of Boston, many members combined the business of the meeting with the pleasant vacation possibilities of the region. In addition there were many distinguished foreign visitors who were in this country to attend the joint meeting and tour of the British Institution of Chemical Engineers and the American Institute of Chemical Engineers in Canada and the United States.

The technical program was featured by three symposia of chemical engineering interest. Under Robert J. McKay of the International Nickel Company, the industrial division had a number of papers and a round-table discussion of corrosion. The latter was participated in by several prominent metallurgists, as well as chemists and engineers. It will be reported in some detail in a subsequent number of *Chem. & Met.*

An economic symposium on nitrogen, presented under the chairmanship of Williams Haynes, featured papers by leading executives in the chemical and fertilizer industries. One of the most comprehensive programs of the meeting was a joint session of the petroleum and gas and fuel divisions in which were twenty papers dealing with some phase of the general subject of "Combustion." It will be briefly interpreted by its chairman, Dr. George Granger Brown, in a later issue of this magazine.

Following the council meeting, Dr. Charles L. Parsons, who had just been re-elected secretary of the society, announced that the sum of $50,800 a year for a period of five years had been pledged by chemical industries for use in improving and expanding the work of *Chemical Abstracts*. This represents a part of the society's major campaign for a fund of $2,000,000, which includes the gift of $250,000 from the Chemical Foundation, announced last Spring. The next national meeting of the American Chemical Society will be held in Columbus, Ohio, during the week of April 29, 1929, and the next Fall meeting is scheduled for Minneapolis during the week of September 10, 1929.

British and American Chemical Engineers Complete Industrial Tour

A PARTY of one hundred and forty British chemical engineers and their guests joined with a representative group from the American Institute of Chemical Engineers for a joint meeting and industrial tour of Eastern Canada and the United States during the last two weeks of August. The Institution of Chemical Engineers of Great Britain, headed by its president, Sir Alexander Gibb, and its secretary, Professor J. W. Hinchley, thus repaid the visit of three years ago when members of the American Institute of Chemical Engineers were the guests of the British Institution during an extended tour in England.

As was true of the English visit, the tour included the inspection of plants and chemical engineering developments in the principal industrial centers. An appropriate technical program was presented at Niagara Falls and at each of the important cities on the itinerary, a local committee provided pleasant entertainment, sightseeing arrangements, etc. Among the places visited were Quebec, Shawinigan Falls, Montreal, Cornwall, Ottawa, Kirkland Lake, Cobalt, Port Colborne, Niagara Falls, Akron, Pittsburgh, Wilmington, Edgewood Arsenal and Washington, D. C.

ABOUT sixty were in the American party that was in Quebec to welcome the British visitors, who arrived during the week-end of August 18. Following the informal reception and introduction of the visitors at Chateau Frontenac, the combined party left at midnight, August 19 for Shawinigan Falls. Two special trains had been provided and these accommodations were retained for the entire tour. At Shawinigan Falls the local chairman, R. A. Witherspoon, vice-president and general manager of the Canada Carbide Co., Ltd., conducted the party through the carbide plant of Shawinigan Chemicals, Ltd., a paper mill of the Belgo division St. Maurice Valley Corp. and the power house of the Shawinigan Water and Power Co. At Montreal on August 21 the chemical engineers were entertained at dinner and left shortly afterward for Cornwall. At this time a part of the group were given an opportunity to visit the large artificial silk plant of Courtalds, Ltd. and the Canadian Cellulose Co. before proceeding to Ottawa. Here the visitors inspected the government buildings of the Dominion's capital.

Kirkland Lake, the important gold mining center, was visited on August 22 and the party saw the operation there of the modern gold mines and cyanide mills. The following day found the party at the nickel and copper refinery of the International Nickel Co., where James H. Rawlins of that company had served as chairman of the local committee.

Arriving at Niagara Falls, Ont., on August 23, the entire group took up headquarters at Hotel Clifton to remain there for three days of combined business and pleasure. In addition to the natural attractions of the region, a local committee, under the chairmanship of F. A. Lidbury had provided a variety of entertainment and recreation. A number of the principal electrochemical and electrometallurgical plants were visited and on Saturday, August 25 a technical session was held at which a number of papers were presented. Several of these are to be published in subsequent numbers of *Chem. & Met.*

The first American city to be visited was Akron, Ohio, where an inspection was made of several of the large rubber factories. The party returned East to stop at Pittsburgh on August 28 where the day was spent in visiting the Mellon Institute of Industrial Research of which E. R. Weidlein, president of the American Institute of Chemical Engineers and the head of the American party is the director. Opportunity was also afforded to see the plant of the American Window Glass Co. as well as the laboratories of the U. S. Bureau of Mines.

The next day found the party in Wilmington, Del., where Dr. Charles L. Reese, as local chairman, had arranged for a comprehensive tour of the dye plants of the duPont company and the Bancroft Finishing Works. That evening the chemical engineers were the guests of Mr. and Mrs. Pierre S. duPont at their estate in Longwood. Here about 400 were entertained at dinner and an outdoor theater performance. Edgewood Arsenal, Md., was visited on August 30 and a local committee headed by A. E. Marshall and made up of representatives of the Chemical Warfare Service and chemical manufacturers provided an entertainment which included a practical demonstration of chemical warfare methods.

Arriving in Washington on August 31 the party made its headquarters at the Mayflower Hotel. A local committee headed by H. E. Howe had provided for two busy days of sightseeing in the Nation's capital, inspection of Governmental laboratories and appropriate entertainment. Among all of the events and occasions of the trip, one of the most notable was the visit to the Grave of the Unknown Soldier and the placing there of a wreath by Sir Alexander Gibb, president of the Institution of Chemical Engineers, Jocelyn Thorpe, president of the Chemical Society of London and F. H. Carr, president of the Society of Chemical Industry. The party returned to New York Sept. 2, in time for the opening on the following day of the annual meeting of the Society of Chemical Industry.

American Engineers Honored

Honorary membership in the Institution of Chemical Engineers of Great Britain has been conferred on Dr. Charles L. Reese of the duPont company and Director E. R. Weidlein of Mellon Institute. Presentation of the awards was made by Sir Alexander Gibb during the Institution's joint meeting with the A.I.Ch.E. in this country.

A. D. Little Installed as President of S.C.I.

THE ANNUAL meeting of the Society of Chemical Industry was held in New York, September 3-7. This was the first meeting of the society held in this country since 1912 and was attended by a large representation of members from England. The meeting was opened by Dr. L. V. Redmond, chairman of the American Section. The annual business meeting was held on September 4 with Francis H. Carr of England, president of the society, presiding. Mr. Carr spoke at some length of the aid the British government has given in stimulating research in the chemical industry.

TECHNICAL features of the meeting included papers on: "Application of Glass to the Chemical and Allied Industries" by A. E. Marshall of Baltimore; "Anti-Knock Motor Fuels" by Dr. Graham Edgar of New York; "Potash and Borax from Searles Lake" by Dr. John E. Teeple of New York; "The American Petroleum Industry" by Dr. Benjamin T. Brooks of New York; "Development of Duco-Type Lacquers" by M. J. Callahan of Parlin, N. J.; "Chemical Treatment for Shortening The Rest Period of Plants" by F. E. Denny of Yonkers; and "Pre-oxidation as a preliminary Treatment to the Low Temperature Distillation of Coal" by Charles H. Foott.

On the evening of September 4 the Messel medal was presented to Dr. Robert A. Millikan, physicist of the California Institute of Technology at Pasadena. This medal is awarded every two years for distinctive work looking to the advancement of some science. The presentation was made by President Carr, and Dr. Millikan delivered an address on "Available Energy."

At the annual dinner on the evening of September 6, Dr. Arthur D. Little of Cambridge, Mass., the newly elected president, was installed. Marston T. Bogart, professor of organic chemistry at Columbia University, was toastmaster. The speakers included Dr. Little, Francis H. Carr, retiring president; Sir Alexander Gibb, and Montrose Strassburger.

Quinine Agreement Reached

The Dutch Kina Bureau has signed the consent decree under which it is pledged not to engage in activities within the United States which are in conflict with the Sherman, Clayton and Wilson acts. The status of the similar negotiations between the Department of Justice and the potash interests remains unchanged.

MARKETING CHEMICALS

MODERNIZATION WITHIN the chemical industry in recent years has been marked not only by greater realization of the importance of plant location, by improvements in processes, and by more scientific management of productive operations but also has been shown in the vast strides which have been taken in the development of new consuming outlets and in the evolution of new materials. That a close relationship has been maintained between supply and demand for chemicals may, in part, be attributed to the increased call for raw materials which has arisen as a result of enlarged operations in manufacturing lines throughout the country. It is equally true that modernization in the production and distribution of chemicals has contributed to the stabilization of the industry.

Progress in the production of chemicals would not of itself suffice to raise the industry to the high position it now holds. Such progress had to be accompanied by the adoption of sales and distribution methods which would permit of an uninterrupted flow from production points to consuming centers. Large-scale economies which have been emphasized in the production of chemicals have found their counterpart in the marketing and distribution of these commodities.

On the following pages have been collated expositions of different methods which have been employed in placing the marketing of chemicals on a modern basis. Discussions also are included relative to the physical movement of these goods.

Growth of Consuming Industries Necessitates Larger Distribution of Chemicals

IN ANY consideration which may be given to the progress which has been made in establishing the marketing of chemicals on a more systematic and economic basis, it will be of interest to take cognizance of conditions in consuming industries which have made necessary the production and delivery of larger volumes of chemical products. Since chemicals enter into practically all manufacturing lines it is a logical sequence that the natural growth of the country and its industries would account for an annual increment in production and consumption of chemicals. With the exception of years in which business depression occurred, this has been the history of the domestic chemical industry from its inception. Gradual progress, however, gave way to rapid growth during the war years when plant capacities were expanded to satisfy the abnormal demand for materials. It was under the exigencies of war-time conditions that the coal-tar and aniline dye industries of this country became established on a large scale.

THREE factors have been prominent in maintaining large-scale consumption of chemicals in the post-war period. Foremost is the remarkable growth in the automobile industry with the swing of production still upward. Enlarged production of cars and trucks had an immediate effect upon demand for paint and varnish. Chemicals were thus drawn upon more freely to supply raw materials for paint and varnish manufacture. Tire production necessarily kept abreast of automobile manufacture. The effect was to augment the movement of rubber-making chemicals. Glass makers likewise were called upon to speed up production in order to fill the increased needs of the automobile trade, and this in turn was reflected in the activity of glass-making chemicals.

The rapid evolution of the lacquer industry was largely due to the rise in automobile production. Without the lacquer industry, it is doubtful if there would have been the incentive to develop the many new solvents which are now found on our markets.

Anti-freeze preparations and oil refining may be included among the branches of the chemical industry which have been stimulated by developments in the automotive field.

A SECOND factor which has laid a favorable impress upon chemical production and consumption, has been the unusually active position of the building trades in the last ten years. Building operations lagged during the war years but took on new life as soon as materials and labor became more plentiful after the cessation of hostilities. Recent activities in building have created new records with every indication that construction will continue to draw heavily upon raw materials. Steel production has gone beyond previous standards with a consequent gain in output of byproduct coke. The larger coke supply has furnished a basis for increased production of coal-tar and coal-tar chemicals.

As a consequence of the rise in building, the paint, varnish, oil, glass, and other trades which are closely allied with chemicals, have been more active.

The Department of Commerce has just announced that, according to data collected at the biennial census of manufactures taken in 1928, the establishments engaged primarily in the production of rayon and allied products in 1927 reported, for that year, a total output valued at $109,888,336, an increase of 24.8 per cent as compared with $88,060,962 for 1925, the last preceding census year.

This industry classification embraces establishments engaged primarily in the production of rayon yarns and of allied products in the form of sheets, etc., but does not cover establishments manufacturing rayon yarns into finished products, such as textiles.

The significance of this report to the chemical trade may be seen from the fact that the rayon industry is largely chemical. Prior to 1925, rayon production was not regarded as important enough to have a place in census compilations. In other words, an industry has grown up in a few years which has directly offered a large outlet for chemicals and indirectly increased the use of chemicals, dyes, and oils, by creating a new branch of manufacture in the textile industry.

According to census returns, the physical volume of production for chemicals and allied products increased 365.6 per cent from 1899 to 1925. The increase is still greater if the comparison is brought up to date although offi-

cial figures are not yet available for volume of production in 1927. Under such conditions it is apparent that sharp increases in demand for chemicals have speeded up production and created new problems in marketing and distribution.

Reference to the growth in the automobile, building, and rayon industries is sufficient to explain, in part, the expansion in chemical consumption in recent years. These trades illustrate how the tonnage movement of chemicals has advanced and they make clear why it has been necessary to modernize marketing and distribution in order to keep the chemical industry on a stable basis.

Improved Packaging a Factor in Movement of Chemical Products

IMPROVEMENTS in the packaging of chemical products has played a prominent part in reducing handling charges, in lowering transportation costs and in giving a lower delivered price to consumers. In its simplest form, this system of delivery is exemplified in the case of bulk shipments where the only container involved is the railroad car, tank wagon, or vessel in which the goods are transported. This method is not applicable to the movement of all chemicals but it has come into wider use in recent years. It has the advantages of eliminating container costs, of reducing loading and unloading costs by making possible mechanical handling, and of doing away with freight charges on the containers which otherwise would have been used. While shipment in bulk dates back to earlier years of the chemical industry, the growth of consuming industries has developed a larger number of buyers in quantities sufficient to make these shipments desirable. The selection of commodities, to which bulk shipments have been extended, also has been increasing and attest the economic value of this phase of distribution.

Closely connected with the shipment of dry chemicals in bulk, may be mentioned the rapid increase which recent years have brought in the use of tank cars and tank wagons. These methods of conveyance hold true for bulk shipments in general but find their greatest application in the movement of liquids whether chemicals or oils. A forward step in this direction was taken by a prominent chemical company which introduced the multi-tank car for transporting liquid chlorine and which has come into use for delivering other commodities. Soap makers and other large consumers of oils have made the tank car the general medium of delivery. In fact, a large percentage of oils originating in foreign countries is now brought into this country in steamer tanks and only a short time ago the first tank cargo of olive oil reached an Atlantic port.

Distribution of chemicals and allied products likewise has undergone a change for the better through the wider use of steel and iron drums. These drums not only offer a guarantee against loss of contents in transit but generally are employed under a return agreement which gives them a long life as a carrier.

Another recent innovation in the transportation of chemicals has been the introduction of specially prepared paper bags. These bags are rendered sufficiently strong to withstand ordinary handling and advantages are claimed for their use in the way of cost and of economy in handling.

Liquid Chemicals Economical in Shipment

FOR MANY years producing and consuming branches of the chlorine industry held that lime was the most efficient carrying agent for that chemical and the greater part of chlorine marketed was in the form of bleaching powder. During the last five years there has been a decided trend in the chlorine trade toward the substitution of liquid chlorine for bleaching powder. To a certain extent this tendency has been influenced by the economic advantages offered by deliveries in tank cars but it is another evidence of modernization in marketing and distribution whereby producers are cooperating with consumers in an effort to lay down at the latter's plants, chemicals in most convenient form and at the lowest possible price.

This trend toward marketing of chemicals in solution has been noted in the case of other solutions, notably sodium silicate, caustic potash, and caustic soda. According to one of the largest distributors of caustic soda, the last half dozen years have witnessed a steady growth in consuming demand for that chemical in liquid form. Thousands of tons are now being shipped in tank cars in the form of a solution containing about equal parts of water and caustic soda. In addition to a cost price differential of about 35c. per 100 lb., this distributor has pointed out that a brief review of the operations in the manufacture and handling of caustic soda, both in solid and in liquid form, will make it clear that the increasing use of liquid caustic is a sound economic development. In the manufacturing process caustic soda is first obtained in the form of a water solution containing from 10 per cent to 25 per cent of sodium hydroxide. To produce solid caustic, it is necessary to drive off *all* the water in this solution by evaporation processes which consume a large amount of fuel. Drums must then be provided for the fused caustic and labor expended in filling, handling and loading these containers for shipment. At the consumer's plant these operations are reversed, the solid caustic being made once more into a water solution with the attendant cost of unloading, handling and cutting open many drums, dissolving the caustic and disposing of the worthless empty drums.

In the case of liquid caustic soda the evaporation process is carried only to the point where the original dilute solution has been boiled down to a concentration of approximately 50 per cent by weight of caustic soda. In this form it is shipped to the consumer in tank cars and handled mechanically by means of suitable piping connected to the car. In the consumer's plant the 50 per cent caustic liquor is readily diluted to the desired concentration for use.

The economic advantages claimed for marketing caustic soda in solution are more or less true when referred to other chemicals which are sold in liquid form.

Tariff Imposts an Aid to Chemical Industry

IMPORT duties on chemicals have had much to do with furnishing protection to the domestic industry and have been a decidedly favorable factor in the growth of the home industry. The flexible provisions of the existing Tariff act likewise have been of service in reducing competition from foreign producing markets. A striking illustration of the beneficial workings of the flexible tariff is found in the case of nitrite of soda. For many years, domestic markets were dominated by the foreign material. As the dye industry of this country was increased, nitrite of soda became of more importance. Attempts were made to develop a home source of supply large enough to fill consuming needs. Competitive selling, however, from the imported material placed domestic producers at a disadvantage and brought about a complete cessation of domestic manufacture. Recourse to the provisions of the flexible tariff was followed by a 50 per cent increase in import duty. Under this protection, production was resumed and gradually arrivals from foreign ports decreased in volume with the result that the domestic material is now taking care of the greater part of American demand.

STATISTICAL COMPARISON OF CHEMICAL AND ALLIED INDUSTRIES, CENSUS YEARS 1899–1925

	Index Numbers: Base 1919							Per Cent of Increase, 1899–1925
	1925	1923	1921	1919	1914	1909	1904	1899	
Chemicals and allied products:									
Physical volume of production	140.6	125.1	94.5	100.0	70.7	58.8	42.9	30.2	365.6
Number of persons engaged	91.8	95.7	77.6	100.0	70.3	60.5	49.5	42.3	117.0
Primary horsepower	147.1	134.8	....	100.0	72.6	49.6	35.0	21.9	571.7

Manufacture of Synthetic Chemicals Creates New Sales Problems

THE PRESENCE on the market of chemicals which were new, either in their application in industry or from a commercial-production standpoint, has been a market factor of prominence in recent years. It is evident that, when newly-produced materials invade the market, an outlet for them must be found in entirely new channels or they must come into direct competition with long established materials. Distributors of chemicals have encountered both these conditions over a more or less lengthy period. In some cases, chemicals of recent commercial origin have passed into consuming fields without encroaching upon the territory of the so-called old-line chemicals. In other cases, the marketing of new products has stirred up the keenest kind of competition with a demoralizing effect on values. In fact a review of the chemical market for the last decade will establish the fact that enlarged production has worked in favor of a lower general price level. Lower prices, in turn, have aided materially in expanding the volume of consumption and modernization in marketing may well be described as being built upon a foundation of prices low enough to encourage increases in consumption.

AMONG the chemicals which deserve the appellation "new," those of synthetic origin are entitled to special consideration. For many years the wood distillation industry of this country had gone along in a position secure from outside competition. Then reports that acetic acid was being produced at low prices in Canada caused some apprehension that this acid might capture the market of the United States. Imports from Canada became a reality but not in disturbing volume and because of tariff differentials, they were largely confined to acid of high concentration. Production of synthetic acid also has been established in this country but has not come into direct market competition with the wood-distillation product.

Demoralized conditions for wood distillation products, however, quickly followed the introduction of synthetic methanol upon our markets. In 1924 the output of this product in Germany had gained such headway that there was a surplus for export. Arrivals at Atlantic ports began to assume sizable proportions and some of the large American producers were credited with entering into long-term contracts with German producers. Arrivals of foreign-made synthetic methanol increased in volume in 1925 and the prices quoted for this material destroyed the stability of the American product and had a most depressing effect upon the wood distillation industry in general. The flexible provisions of the tariff act were invoked and after an exhaustive study of producing costs in Germany and in this country, the Tariff Commission recommended an increase of 50 per cent in import duty on methanol. Even under a tariff handicap of 18c. per gal. the synthetic material was able to offer competition but the situation became further complicated by the establishment of domestic production of synthetic methanol. The synthetic product competes only with the pure grade of methanol made by wood distillation. The latter, therefore, still holds its position as a denaturant for ethyl alcohol but in other consuming fields the market is now dominated by synthetic methanol. While these changes in the methanol industry, in themselves, are due to developments connected with production, they emphasize the fact that improved production methods bring about important changes in marketing. The lower cost of producing synthetic methanol has placed it in a more favorable competitive position in the solvent field and thus widened its consumptive possibilities. It also directs attention to the closer connection which is being drawn between the sales problems of the producer and the technical requirements of the consumer. In order to develop sales volume to its maximum, producers of methanol, as well as of other chemicals, are finding it advantageous, in their sales campaign, to stress the adaptations to which their products may be applied and the sales engineer is given more prominence in the marketing and distribution of chemicals.

THE tremendous growth in demand for coatings for automobile bodies which arose after the war looms large in the development of another phase of chemical manufacture. To meet this demand the pyroxylin lacquer industry came into existence. Its growth has been rapid and continuous. Coincident with this growth, is the expansion in variety and volume of solvents which are necessary in lacquer manufacture. At present production and distribution of lacquer holds a high place in the output of chemicals. Pigments, lakes, acids, gums and resins, cellulose acetate, and other raw materials likewise are finding greatly enlarged outlets as a result of the rise in lacquer manufacture. The effect on the marketing of these products is obvious. New selling factors have appeared, the tonnage movement has increased to a point where new transportation problems had to be solved, and the influx of varied competitive selections has made price considerations important. Larger production has influenced the price trend downward and low prices for the materials has completed the circle by encouraging increased consumption.

IN THE fertilizer trade the agricultural-nitrogen problem has been the outstanding factor in bringing about changes in marketing. Fixation of nitrogen from the air has made such progress in the last few years that it has cut deeply into the field formerly monopolized by natural nitrates. The effects of this production have been felt principally in Europe. As a case in point the production of nitrogen products in Germany for the year ending June 30, 1928, is estimated at 660,000 tons of pure nitrogen of which about 420,000 tons is believed to have been consumed in Germany and 240,000 tons exported. Of this quantity it is estimated that about 60,000 tons was byproduct and 310,000 tons synthetic sulphate of ammonia, 80,000 tons cyanamide, 75,000 tons nitrate of lime, 25,000 tons nitrate of soda, 70,000 tons Leuna saltpeter and 40,000 tons in the form of urea, Nitrophoska and other products. These figures represent an increase of about 80,000 tons on the production of the previous year. In the coming year a further increase of about 120,000 tons is expected, of which 20,000 tons will be byproduct sulphate of ammonia and 100,000 tons synthetic nitrogen.

THIS increase in nitrogen supply clearly indicates the lines along which fertilizer-material in Europe has been progressing. It accounts for the falling off in shipments of nitrate of soda to European countries and also accounts for the depression which marked the Chilean nitrate industry in 1926 and 1927.

In the domestic fertilizer trade the influence of synthetic materials has consisted mainly in imports from Europe. However, preparations for placing a domestic supply of such materials on the market, are nearing completion and marketing problems undoubtedly will become more complex.

DEVELOPMENTS in the market for aqua and anhydrous ammonia closely parallel those as reported for methanol. In the latter part of 1925, a synthetic product was offered in large volume and a keen competition for market supremacy arose between the new material and ammonia made from coal-tar byproducts. Again the victory was gained by the synthetic product through its ability to create and maintain a price level about one-half that which had prevailed over a long period. In fact, competition quickly developed among producers of synthetic ammonia and, so large was the output of manufacturing plants, a surplus of offerings made it difficult to hold the market in a stable position and selling prices were largely a matter of private negotiation with buyers occupying a position of advantage. Since then production has been kept within bounds and consumption has increased so there has been an equitable balance between the two. Low prices, however, have been continued. Hence ammonia is a second example of the influence which synthetic production of chemicals has had upon the market not only as a price factor but also as an exponent of enlarging consumption.

Trade Associations Promote Modernization in Marketing Chemicals

CONCERTED effort toward the advancement of the chemical and allied industry is the aim of the different trade organizations which represent different branches of the industry. The influence which these associations exert upon marketing may be exemplified by a survey which the Industrial alcohol Institute recently completed. The survey was devoted to a study of what the institute had accomplished during its existence. It showed that the association has brought about a noteworthy improvement in the conditions surrounding the major industry in which its members are engaged while co-operating to the fullest extent with Federal authorities in educating the public in the legitimate uses of commercial alcohol.

As a result of its operations, the institute has made the production and marketing of denatured alcohol more satisfactory for its members. Their stocks on hand are today less than they have been in a long time. The combined inventories of all its members on June 30, 1928, were 48 per cent less than on the corresponding date last year.

The Industrial Alcohol Institute is devoting a great deal of time and expending a large amount of money on a campaign directed to show the extensive and proper uses for its members' product. While these uses are known to be in excess of four hundred various employments, the institute is demonstrating that they are almost unlimited.

THE members, fourteen in number, with a combined capitalization in excess of $100,000,000, are producing 97 per cent of the 85,000,000 gal. of industrial alcohol which the government has set as the maximum quantity to be manufactured during the year 1928.

The collaboration of the institute with governmental bureaus has during the short period of its existence produced definite results in educating the users of alcohol in the proper use of this basic and most necessary chemical.

Each member of the institute maintains a research laboratory within its own organization, and, in addition to this, the institute itself supports a research fellowship in the Mellon Institute in Pittsburgh.

These economic and scientific achievements are all the more remarkable because of their consummation in the face of a steadily rising market for molasses which is the raw material from which ethyl alcohol is principally made. Curtailment of sugar production by the Cuban government with the consequent reduction of molasses supply from that island has been chiefly responsible for this recent sharp uplift in the price of molasses.

In its educational campaign, the Industrial Alcohol Institute has successfully demonstrated that industrial alcohol is an every-day necessity, in one form or another, from the cradle to the grave, from arising to retiring, and without it the tremendous progress made by the American chemical industry since the war would not have been possible.

Other benefits derived from association work have been in connection with bringing about legislation, Federal or State, favorable to the industry or in preventing legislative action which would be detrimental to the industry.

ONLY a few years ago the fertilizer industry was in a state of depression not only because a large consuming section of the country had curtailed buying but because of the selling methods which had been pursued in preceding years. Sales of fertilizer had been made on long-term credits with payment largely dependent on the outcome of crops. A succession of unfavorable crop years placed agriculturists in a position where they were unable to take up their financial obligations and these frozen assets of fertilizer manufacturers ultimately were written off to profit and loss. The fertilizer trade then took common steps to place marketing of its products on a more dependable basis and the last few years have brought a large increase in sales of fertilizer with the producer no longer carrying the financial burden.

Foreign Trade in Chemicals Stimulated by Government Assistance

UNDER the stimulating assistance of the Department of Commerce export sales of chemicals and allied products have been forging ahead. The Department through its representatives in foreign centers has collected and disseminated valuable information regarding consuming requirements in practically all the countries of the globe. In addition to data on material consumption, this information has included expositions on the methods of doing business in the different countries, terms of credit, furnishing credit ratings of individual firms, instructions on packaging, explanations of import regulations—in fact complete information relative to trading with foreign countries.

The status of foreign trade may be illustrated by reference to a recent report which stated that foreign trade in chemicals and allied products during the first six months of 1928 recorded more interesting changes than have taken place for a long time. On the whole, the transactions may be considered favorable to American business. Both exports and imports were large, and imports exceptionally so because of the unusual amounts of nitrogenous fertilizers received. The majority of other import items fell somewhat below the figures for the corresponding period of 1927, while the greater number of export commodities registered gains.

THE outstanding record in the outbound trade was the considerable progress made in foreign sales of chemical specialties. Nearly half as much again was exported in the six months of 1928 as during the corresponding period of 1927. In the inbound trade the 65 per cent gain in receipts of fertilizers outclassed all other incidents.

If the commodities included in the trade be arranged into manufactured and raw or semi-manufactured materials, three-fifths of the total export, or $57,000,000 worth, was accounted for by manufactured goods. Exports of manufactured goods exceeded those of the first half of 1927 by 11 per cent and surpassed imports by $32,000,000.

The composition of imports showed a sharp contrast to that of exports—three-quarters of the total, or $90,000,000 worth, comprised of crude or semi-prepared materials, and only one-quarter, or $25,000,000, made up of manufactured goods. Imports of manufactured goods showed a loss of $4,000,000 from the value of the first half of the preceding year, while receipts of crude and semi-manufactured goods not indigenous to the United States advanced $15,000,000.

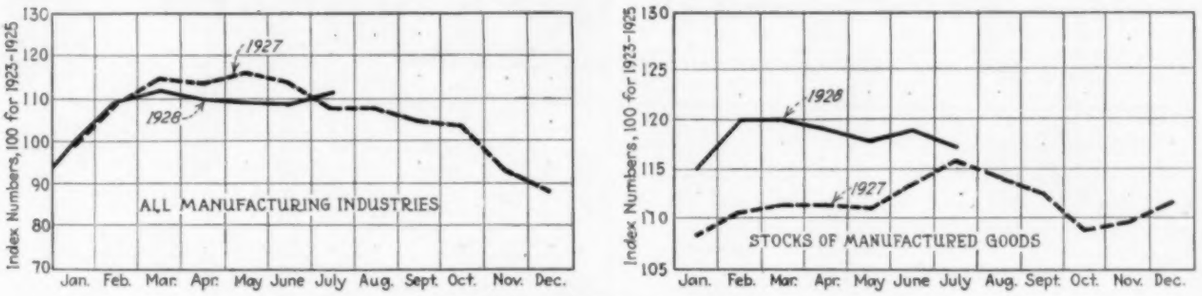
IN THE industrial chemical trade the 47 per cent gain in exports of specialties stood out conspicuously. Total foreign sales of industrial chemical specialties advanced from $5,266,000 to $7,740,000. Disinfectants, insecticides, and similar preparations continued their upward movement with a total foreign distribution of $3,080,000.

Small export gains were noted during the current half year for the majority of industrial chemicals, the exception being sodium borate, which more than doubled, an exportation of $2,258,000.

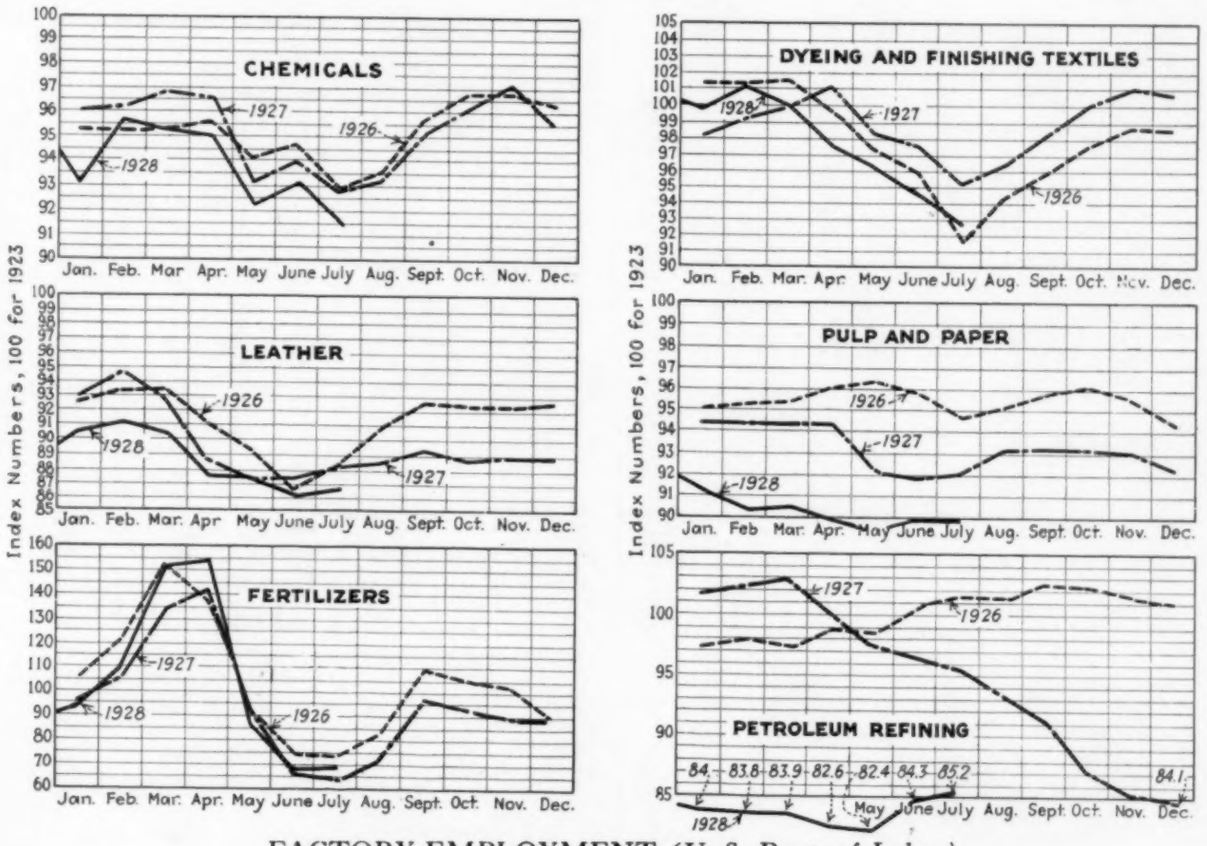
What is true of foreign trade in the first six months of this year is largely an index of the progress recorded in preceding years. The trend has been toward exports of finished chemical products and imports of raw materials which are not native to this country.

The trend toward collective marketing in the export trade has been in evidence since 1918 when the Webb-Pomerene law was enacted. The purpose of this law was to permit competing companies in this country to unite in meeting competition in foreign markets. The Alkali Export Association has operated under the provisions of this law and has taken direct charge of export sales and shipments of alkalies. Under central direction and control, results undoubtely have been better than would have been the case if the producing companies acted separately.

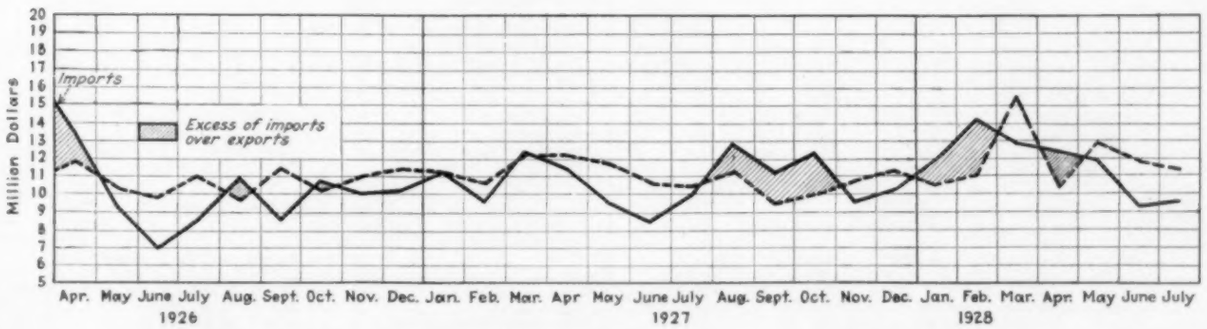
Indexes of Activity in Producing and Consuming Industries



VOLUME OF PRODUCTION *(U. S. Dept. of Commerce)*



FACTORY EMPLOYMENT *(U. S. Dept. of Labor)*


Million Dollars
Imports
Excess of imports over exports
Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July
1926
1927
1928

FOREIGN TRADE IN CHEMICALS AND ALLIED PRODUCTS

CURRENT PRICES *in the* NEW YORK MARKET

For Chemicals, Oils and Allied Products

The following prices refer to round lots in the New York Market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to September 17.

Industrial Chemicals

		Current Price	Last Month	Last Year
Acetone, drums	lb.	$0 14 -$0 15	$0 14 -$0 15	$0.12 -$0.13
Acid, acetic, 28%, bbl	cwt.	3 62½- 3 87½	3 62½- 3.87½	3 38 - 3 63
Boric, bbl	lb.	.06½- .07	.06½- .07	.08½- .08½
Citric, kegs	lb.	.46 - .47	.46 - .47	.44½- .45
Formic, bbl	lb.	.11 - .12	.11 - .12	.11 - .12
Cailic, tech., bbl	lb.	.50 - .55	.50 - .55	.50 - .55
Hydrofluoric 30% carb.	lb.	.06 - .07	.06 - .07	.06 - 07
Lactic, 44%, tech., light, bbl	lb.	.12 - .12½	.12 - .12½	.13½- 14
22%, tech., light, bbl	lb.	.05½- .06	.05½- .06	.06½- 07
Muriatic, 18°, tanks	cwt.	.85 - .90	.85 - .90	85 - .90
Nitric, 36°, carboys	lb.	.05 - .05½	.05 - .05¼	05 - .05½
Oleum, tanks, wks.	ton	18.00 -20.00	18.00 -20.00	18 00- 20.00
Oxalic, crystals, bbl	lb.	.11 - .11½	.11 - .11½	.11 - .11½
Phosphoric, tech., c'bys	lb.	.08½- .09	.08½- .09	.08½- 09
Sulphuric, 60°, tanks	ton	11.00 -11.50	11.00 -11.50	10.50 -11 00
Tannic, tech., bbl	lb.	.35 - .40	.35 - .40	.35 - .40
Tartaric, powd., bbl	lb.	.38 - .38½	.38 - .38½	.37 - .37½
Tungstic, bbl	lb.	1 00 - 1 20	1 00 - 1 20	1 00 - 1 20
Alcohol, ethyl, 190 p'f., bbl.	gal.	2 68½- 2.71	2.68½- 2.71	3.75 - 4.00
Alcohol, Butyl, dr	lb.	.18½- .19	.18½- .19	19 - 20
Denatured, 190 proof				
No. 1 special dr	gal.	.47 -	.46	.48 -
No. 5, 188 proof, dr	gal.	.47 -	.45	.48 -
Alum, ammonia, lump, bbl	lb.	.03½- .04	.03½- .04	.03½- .04
Chrome, bbl	lb.	.05½- .05½	.05½- .05½	.05½- .06
Potash, lump, bbl	lb.	.02½- .03½	.02½- .03½	.02½- .03½
Aluminum sulphate, com., bags	cwt.	1.40 - 1.45	1.40 - 1.45	1.40 - 1.45
Iron free, bg	cwt.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Aqua ammonia, 26°, drums	lb.	.03½- .04	.03 - .04	.02½- .03
Ammonia, anhydrous, cyl	lb.	.13½-	.13½-	.11 - .13
Ammonium carbonate, powd. tech., casks	lb.	.12 - .13	.12 - .13	.10½- .14
Sulphate, wks	cwt.	2 40 -	2 35 -	2 25 -
Amylacetate tech., drums	gal.	1 75 - 2 00	1 75 - 2 00	2 15 - 2 20
Antimony Oxide, bbl	lb.	.10½- .10½	.12 - .12½	.16 - .16½
Arsenic, white, powd., bbl	lb.	.04 - .04½	.04 - .04½	.03½- .04½
Red, powd., kegs	lb.	.09 - .10	.09 - .10	.08½ 09
Barium carbonate, bbl	ton	57 50 - 60 00	60 00 -62 00	50 00 -52 00
Chloride, bbl	ton	63 00 - 70 00	57 00 -58.00	58 00 -60.00
Nitrate, casks	lb.	.07½- .08	.07½- .08	.08 - .08½
Blanc fixe, dry, bbl	lb.	.03½- .04	.03½- .04	.04 - .04½
Bleaching powder, f.o.b., wks., drums	cwt.	2 00 - 2.10	2 00 - 2.10	2.00 - 2.10
Borax, bbl	lb.	.02½- .03	.02½- .03	.04½ - .04½
Bromine, cs	lb.	.45 - .47	.45 - .47	.45 - .47
Calcium acetate, bags	cwt.	4 00 -	3.50 -	3 50 -
Arsenate, dr	lb.	.06½- .07	.06½- .07	.07½ 08
Carbide drums	lb.	.05 - .06	.05 - .06	05 - 06
Chloride, fused, dr., wks.	ton	20 00 -	20 00 -	21 00 -
Phosphate, bbl	lb.	.07 - .07½	.07 - .07½	.07 - .07½
Carbon bisulphide, drums	lb.	.05 - 06	.05 - .06	.05½- 06
Tetrachloride drums	lb.	.06½- .07	.06½- .07	.06½- 07
Chlorine, liquid, tanks, wks.	lb.	.03½- .04½	.03½- .04½	.04 - .04½
Cylinders	lb.	.05½- .08	.05½- .08	.05½- .08
Cobalt oxide, cans	lb.	2 10 - 2 20	2 10 - 2.20	2.10 - 2 25
Copperas, bgs., f.o.b. wks.	ton	16 00 17 00	16 00- 17 00	14 00 -17.00
Copper carbonate, bbl	lb.	17 - .17½	.17 - .17½	.17 - .18
Cyanide, tech., bbl	lb.	.49 - 50	.49 - .50	.49 - 50
Sulphate, bbl	cwt.	5 30 - 5 50	5 30 - 5 50	4 90 - 5 00
Cream of tartar, bbl	lb	.27½ - .28	.26½- .27	.26½- .27
Diethylene glycol, dr.	lb.	.10 - .15	.10 - .15	- -
Epsom salt, dom., tech., bbl.	cwt.	1 75 - 2.15	1.75 - 2.00	1 75 - 2 00
Imp., tech., bags	cwt.	1.15 - 1 25	1.15 - 1.25	1 35 - 1 40
Ethyl acetate, drums	gal.	.82 - .84	.82 - .84	.74 - 76
Formaldehyde, 40%, bbl	lb.	.08½- .09	.08 - .08½	.11½ 11½
Furfural, dr	lb.	.15 - .17½	.15 - .17½	.15 - 17
Fusel oil, crude, drums	gal.	1 30 - 1 40	1 30 - 1 40	1 40 - 1 50
Refined, dr	gal.	2.50 - 3.00	2.50 - 3 00	2 50 - 3 00
Glaubers salt, bags	cwt	1 10 - 1.20	1.10 - 1.20	1 00 - 1 10
Glycerine, e.p., drums, extra	lb.	.14 - .15	.14 - .15	.23 - .24
Lead:				
White, basic carbonate, dry, casks	lb.	.08½-	.08½-	.09 -
White, basic sulphate, sck	lb.	.07½-	.07½-	.08½-
Red, dry, sck	lb.	.09½-	.09½-	.10½-
Lead acetate, white crys., bbl.	lb.	.13 - .13½	.13 - .13½	.13 - .13½
Lead arsenate, powd., bbl	lb.	.13 - .14	.13 - .14	.12 - .13
Lime, chem., bulk	ton	8.50 -	8.50 -	8.50 -
Litharge, pwd., csk	lb.	.08½-	.08½-	.09½-
Lithopone, bags	lb.	.05½- .06	.05½- .06	.05½- .06½
Magnesium carb., tech., bags	lb.	.06½- .07	.06½- .07	.07½- 08
Methanol, 95%, dr	gal.	.55 -	.55 -	.55 -
97%, dr	gal.	.55 -	.55 -	.55 -
Nickel salt, double, bbl	lb.	.10 - .10½	.10 - .10½	.10 - .10
Single, bbl	lb.	.10½- .11½	.10½- .11	.10½- .11½
Orange mineral, csk	lb.	$0.11½-	$0.11½-	$0 12½-
Phosphorus, red, cases	lb.	.62 - .65	.62 - .65	.62 - .65
Yellow, cases	lb.	.32 - .33	.32 - .34	.32 - .33
Potassium bichromate, casks	lb.	.08½- .08½	.08½- .08½	.08½- .08½
Carbonate, 80-85%, calc., csk	lb	.05½- .06	.05½- .06	.05½- .06
Chlorate, powd	lb.	.06½- .07	.06½- .07	.08½- .09
Cyanide, cs	lb.	.52 - .55	.51 - .53	.55 - .57
First sorts, csk	lb.	.08½- .09	.08½- .09	.08½- .09
Hydroxide(c'stic potash)	dr. lb.	.07½- .07½	.07½- .07½	.07½- .07½
Muriate, 80% bgs	ton	36 40 -	36.40 -	36.40 -
Nitrate, bbl	lb.	.06 - .05½	.06 - .06½	.06 - .07½
Permanganate, drums	lb.	.15 - .16	.15 - .16	.14 - .15
Prussiate, yellow, casks	lb.	.17½- .19	.17½- .19	.18½- .19
Sal ammoniac, white, casks	lb.	.047- .05	.047- .05	.05½- .06
Salsoda, bbl	cwt.	.90 - .95	.90 - .95	.90 - .95
Salt cake, bulk	ton	14.00 -17.00	14.00 -17.00	17.00 -19.00
Soda ash, light, 58%, bags, contract	cwt.	1.32 -	1.32 -	1.32½-
Dense, bags	cwt.	1.35 -	1.35 -	1.37½-
Soda, caustic, 76%, solid, drums, contract	cwt.	2.80 - 3.00	2.80 - 3.00	3.00 - 3.10
Acetate, works, bbl	lb.	.05½- .06	.05½- .06½	.04½- .05
Bicarbonate, bbl	cwt.	2.00 - 2 25	2.00 - 2.25	2.00 - 2.25
Bichromate, casks	lb.	.07 - .07½	.07 - .07½	.06½- .06½
Bisulphate, bulk	ton	3.00 - 3.50	3.00 - 3.50	5.00 - 5.50
Bisulphite, bbl	lb.	.03½- .03½	.03½- .03½	.03½- .04
Chlorate, kegs	lb.	.05½- .06	.05½- .06	.06½- .06½
Chloride, tech	ton	12.00 -14.75	12.00- 14.75	12.00 -14.00
Cyanide, cases, dom	lb.	.18 - .22	.18 - .22	.18 - .22
Fluoride, bbl	lb.	.08½- .09½	.08½- .09½	.08½- .09
Hyposulphite, bbl		2 50 - 3.00	2.50 - 3.00	2.50 - 3.00
Nitrate, bags	cwt.	2 15 -	2 22½-	2.50 -
Nitrite, casks	lb.	.07½- .08	.07½- .08	.08 - .08½
Phosphate, dibasic, bbl	lb.	.03 - .03½	.03 - .03½	.03½- .03½
Prussiate, yel. drums	lb.	.11 - .12	.11 - .12	.12 - .12½
Silicate (30°, drums)	cwt.	.75 - 1.15	.75 - 1.15	.75 - 1.15
Sulphide, fused, 60-62%, dr.	lb.	.02½- .03½	.02½- .03	.03½- .04
Sulphite, crys., bbl	lb.	.02½- .03	.02½- .03	.02½- .03
Strontium nitrate, bbl	lb.	.09 - .09½	.09 - .09½	.08½- .09
Sulphur, crude at mine, bulk	ton	18.00 -	18.00 -	18.00 -
Chloride, dr	lb.	.04 - .05	.04 - .05	.05 - .05½
Dioxide, cyl	lb.	.09 - .10	.09 - .10	.09 - .10
Flour, bag	cwt.	2.70 - 3.00	2.70 - 3.00	2.70 - 3.00
Tin bichloride, bbl	lb.	.14½-	.14½-	.19 -
Oxide, bbl	lb.	.53 -	.53 -	.66 -
Crystals, bbl	lb.	.37 -	.36½-	.44½-
Zinc chloride, gran., bbl	lb.	.06½- .06½	.06½- .06½	.06½- .06½
Carbonate, bbl	lb.	.10 - .11	.10 - .10½	.10 - .11
Cyanide, dr	lb.	.40 - .41	.40 - .41	.40 - .41
Dust, bbl	lb.	.08½- .09	.08½- .09	.09½- .10
Zinc oxide, lead free, bag	lb.	.06½-	.06½-	.06½-
5% lead sulphate, bags	lb.	.06½-	.06½-	.06½-
Sulphate, bbl	cwt	2.75 - 3.00	2 75 - 3.00	2 75 - 3.00

Oils and Fats

		Current Price	Last Month	Last Year
Castor oil, No. 3, bbl	lb.	$0.12½-$0.13	$0.12½ $0.13	$0.12½-$0 13
Chinawood oil, bbl	lb.	.14½-	.15½-	.17½-
Coconut oil, Ceylon, tanks, N. Y.	lb.	.08½-	.08½-	.08½
Corn oil crude, tanks, (f.o.b. mill)	lb.	.08½-	.08½	.09½-
Cottonseed oil, crude (f.o.b. mill), tanks	lb.	.08 -	.08 -	.10 -
Linseed oil, raw, car lots, bbl	lb.	.096	.097-	104 -
Palm, Lagos, casks	lb.	.08 -	.08 -	.08½-
Niger, casks	lb.	.07½-	.07½-	.07½-
Palm Kernel, bbl	lb.	.09½-	.09½-	.08½-
Peanut oil, crude, tanks(mill)	lb.	.09½-	.08½-	.11 -
Rapeseed oil, refined, bbl	gal.	.88 - .90	90 - .92	.78 - .80
Sesame, bbl	lb.	- -	- -	- -
Soya bean tank (f.o.b. Coast)	lb	.09½-	.09½-	.09½-
Sulphur(olive foots), bbl	lb	.10½-	.10½-	.08½-
Cod, Newfoundland, bbl	gal.	65 - 67	68 - .69	.63 - .65
Menhaden, light pressed, bbl	gal	60 - 61	62 - .64	60 - .62
Crude, tanks(f.o.b. factory)	gal	.41 -	45 -	.41 -
Whale, crude, tanks	gal.	.73 -	73 -	- -
Grease, yellow, loose	lb.	.07½-	.07½-	.06½-
Oleo stearine	lb.	.10½-	.09½-	.09½-
Red oil, distilled, d.p. bbl	lb.	.09½- .09¾	.09½- .09¾	.09½- .09¾
Tallow, extra, loose	lb.	.08½-	.08 -	.08 -

Coal-Tar Products

		Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl	lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl	lb.	.85 - .90	.85 - .90	.85 - .90
Alpha-naphthylamine, bbl	lb.	.35 - .36	.35 - .36	.35 - .36
Aniline oil, drums, extra	lb.	.15 - .16	.15 - .16	.15 - 16
Aniline salts, bbl	lb.	.24 - .25	.24 - .25	.24 - .25
Anthracene, 80%, drums	lb.	.60 - .65	.60 - .65	60 - .65

Coal Tar Products (Continued)

		Current Price	Last Month	Last Year
Benzaldehyde, U.S.P., dr.	lb.	1.15 - 1.25	1.15 - 1.35	1.15 - 1.25
Benzidine base, bbl.	lb.	.70 - .72	.70 - .75	.70 - .72
Benzoic acid, U.S.P., kgs.	lb.	.58 - .60	.58 - .60	.58 - .60
Benzyl chloride, tech, dr.	lb.	.25 - .26	.25 - .26	.25 - .26
Benzol, 90%, tanks, works	gal.	.22 - .23	.22 - .23	.24 - .25
Beta-naphthol, tech., drums	lb.	.22 - .24	.22 - .24	.22 - .24
Cresol, U.S.P., dr.	lb.	.18 - .20	.18 - .20	.18 - .20
Cresylic acid, 97%, dr., wks	gal.	.73 - .75	.73 - .75	.61 - .62
Diethylaniline, dr.	lb.	.58 - .60	.58 - .60	.58 - .60
Dinitrophenol, bbl.	lb.	.31 - .35	.31 - .33	.31 - .35
Dinitrotoluen, bbl.	lb.	.17 - .18	.17 - .18	.17 - .18
Dip oil, 25% dr.	gal.	.28 - .30	.28 - .30	.28 - .30
Diphenylamine, bbl.	lb.	.45 - .47	.45 - .47	.45 - .47
H-acid, bbl.	lb.	.63 - .65	.63 - .65	.63 - .65
Naphthalene, flake, bbl.	lb.	.05 - .06	.05 - .06	.04½ - .05
Nitrobenzene, dr.	lb.	.08½ - .10	.08½ - .10	.09 - .10
Para-nitraniline, bbl.	lb.	.52 - .53	.52 - .53	.52 - .53
Para-nitrotoluine, bbl.	lb.	.28 - .32	.28 - .32	.28 - .32
Phenol, U.S.P., drums	lb.	.13½ - .14	.15 - .17	.17 - .18
Picric acid, bbl.	lb.	.30 - .40	.30 - .40	.25 - .26
Pyridine, dr.	lb.	1.35 - 1.50	1.35 - 1.50	3.00 - .....
R-salt, bbl.	lb.	.47 - .50	.47 - .50	.47 - .50
Resorcinal, tech, kegs.	lb.	1.30 - 1.35	1.30 - 1.35	1.30 - 1.40
Salicylic acid, tech., bbl.	lb.	.30 - .32	.30 - .32	.30 - .32
Solvent naphtha, w.w.,tanks	gal.	.35 -	.35 -	.35 - .....
Tolidine, bbl.	lb.	.95 - .95	.95 - .96	.95 - .96
Toluene, tanks, works	gal.	.35 -	.35 -	.35 - .....
Xylene, com., tanks	gal.	.36 - .41	.36 - .41	.36 - .40

Miscellaneous

		Current Price	Last Month	Last Year
Barytes, grd., white, bbl.	ton	$23.00-$25.00	$23.00-$25.00	$23.00-$25.00
Casein, tech., bbl.	lb.	.16½ - .17	.15½ - .16	.17½ - .18
China clay, dom.,f.o.b. mine	ton	10.00 -20.00	10.00 -20.00	10.00 -20.00
Dry colors:				
Carbon gas, black (wks.)	lb.	.07½ - .08	.06½ - .07	.06½ - .07
Prussian blue, bbl.	lb.	.31 - .33	.31 - .33	.33 - .34
Ultramine blue, bbl.	lb.	.08 - .35	.08 - .35	.08 - .35
Chrome green, bbl.	lb.	.27 - .31	.27 - .30	.27 - .30
Carmine red, tins	lb.	5.25 - 5.50	5.25 - 5.50	5.50 - 5.75
Para toner	lb.	.60 - .70	.60 - .70	.80 - .90
Vermilion, English, bbl.	lb.	1.80 - 1.85	1.80 - 1.85	1.80 - 1.85
Chrome yellow, C. P., bbl.	lb.	.15½ - .16	.15½ - .16	.17 - .18
Feldspar, No. 1 (f.o.b. N. C.)	ton	5.75 - 7.00	5.75 - 7.00	5.75 - 7.00
Graphite, Ceylon, lump, bbl	lb.	.08 - .08½	.08 - .08½	.08 - .09
Gum copal, Congo, bags	lb.	.07½ - .08	.07½ - .08	.09½ - .10
Manila, bags	lb.	.15 - .18	.15 - .16	.15 - .18
Damar, Batavia, cases	lb.	.22 - .23	.22 - .23	.25 - .25
Kauri, No. 1 cases	lb.	.48 - .53	.48 - .53	.55 - .57
Kieselguhr (f.o.b. N. Y.)	ton	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc.	ton	40.00 -	40.00 -	44.00 - .....
Pumice stone, lump, bbl.	lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks	lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H	bbl.	9.35 -	9.85 -	10.25 - .....
Turpentine	gal.	.51½ -	.53½ -	.57 - .....
Shellac, orange, fine, bags	lb.	.61 -	.61 -	.52 - .53
Bleached, bonedry, bags	lb.	.60 - .66	.60 - .66	.59 - .61
T. N. bags	lb.	.47 - .48	.47 - .48	.40 - .45
Soapstone (f.o.b. Vt.), bags	ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.)	ton	9.50 -	9.50 -	10.50 - .....
300 mesh (f.o.b. Ga.)	ton	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.)	ton	13.75 -	13.75 -	13.75 - .....

		Current Price	Last Month	Last Year
Wax, Bayberry, bbl.	lb.	$0.31 -$0.32	$0.30 -$0.32	$0.25 -$0.26
Beeswax, ref., light	lb.	.41 - .42	.41 - .42	.45 - .46
Candelilla, bags	lb.	.23 - .24	.23 - .24	.33 - .34
Carnauba, No. 1, bags	lb.	.46 - .48	.50 - .51	.65 - .70
Paraffine, crude 105-110 m.p.	lb	.04½ - .05	.04½ - .05	.05½ - .06

Ferro-Alloys

		Current Price	Last Month	Last Year
Ferrotitanium, 15-18%	ton	$200.00-	$200.00-	$200.00- .....
Ferromanganese, 78-82%	ton	105.00-	105.00-	90.00- .....
Spiegeleisen, 19-21%	ton	32.00-	32.00-	33.00 35.00
Ferrosilicon, 14-17%	ton	45.00-	45.00-	.....
Ferrotungsten, 70-80%	lb.	.95 - .98	.95 - .98	.95 - .98
Ferro-uranium, 35-50%	lb.	4.50-	4.50-	4.50- .....
Ferrovanadium, 30-40%	lb.	3.15 - 3.75	3.15 - 3.75	3.15 - 3.75

Non-Ferrous Metals

		Current Price	Last Month	Last Year
Copper, electrolytic	lb.	$0.14½-	$0.14½ -	$0.133- .....
Aluminum, 96-99%	lb.	.24 - .26	.24 - .26	.26 - .28
Antimony, Chin. and Jap.	lb.	.09½ -	.09½ -	.12 - .....
Nickel, 99%	lb.	.33 -	.33 -	.35 - .....
Monel metal, blocks	lb.	.28 -	.28 - .28	.32 - .33
Tin, 5-ton lots, Straits	lb.	.49 -	.49 -	64½ - .....
Lead, New York, spot	lb.	6.20 -	6.20 -	6.75 - .....
Zinc, New York, spot	lb.	6.60 -	6.60 -	6.70 - .....
Silver, commercial	oz.	.59 -	.59 -	.57⅞ - .....
Cadmium	lb.	.60 -	.60 -	60 - .....
Bismuth, ton lots	lb.	1.85 - 2.10	1.85 - 2.00	2.20 - 2.25
Cobalt	lb.	2.50 -	2.50 -	2.50 - .....
Magnesium, ingots, 99%	lb.	.98 -	98 -	75 - .80
Platinum, ref.	oz.	76.00 - 76.50	76.00- 76.50	86.00- .....
Palladium, ref.	oz.	46.00 - 49.00	46.00- 49.00	59.00-63.00
Mercury, flask..... 75	lb.	122.50-	122.50-	121.00- .....
Tungsten powder	lb.	1.05 - 1.15	1.05-	1.05- .....

Ores and Semi-finished Products

		Current Price	Last Month	Last Year
Bauxite, crushed, wks.	ton	$7.50- $8.00	$7.50- $8.50	$5.50- $8.75
Chrome ore, c.f. post	ton	22.00- 24.00	22.00- 24.00	22.00- 23.00
Coke, fdry., f.o.b. ovens	ton	2.85- 3.00	2.85- 3.00	3.25- 3.75
Fluorspar, gravel, f.o.b. Ill.	ton	16.00-	16.00-	17.00- .....
Ilmenite, 52% TiO_2, Va.	lb.	.00⅜ - .00½	.00½ - .00¾	.00⅝ - .....
Manganese ore, 50% Mn., c.i.f. Atlantic Ports	unit	.36 - .38	.36 - .38	.36 - 38
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y.	lb.	.48 - .50	.48 - .50	.48 - .50
Monazite, 6% of ThO_2	ton	130.00-	130.00-	120.00- .....
Pyrites, Span. fines, c.i.f.	unit	.13 -	.13 -	.13½ - .....
Rutile, 94-96% TiO_2	lb.	.11 - .13	.11 - .13	.11 - .13
Tungsten, scheelite, 60% WO_3 and over	unit	10.50 -10.75	10.50 -10.75	11.25 -11.50
Vanadium ore, per lb. V_2O_5	lb.	nom.	nom.	25 - 28
Zircon, 99%	lb.	.03 -	.03 -	.03 - .....

CURRENT INDUSTRIAL DEVELOPMENTS

New Construction and Machinery Requirements

Aluminum Factory—U. S. Aluminum Co., Post Rd., Fairfield, Conn., awarded contract for a 1 and 2 story, 220 x 470 ft. factory and 65 x 140 ft. service building to C. A. Fritz, Pittsburg, Pa. Estimated cost $275,000.

Brass Foundry—M. S. Little Mfg. Co., 151 New Park Ave., Hartford, Conn., will soon award contract for a 1 story, 50 x 120 ft. addition to brass foundry. Estimated cost $40,000. W. W. Dolliver, 136 Kent St., Hartford, Conn., is architect.

By-Products Plant—Florida By-Products Co., Inc., Jacksonville, Fla., plans the construction of a new dry-rendering plant. Estimated cost $25,000.

Candy Factory — Mars Inc., 2019-59 North Oak St., Chicago, Ill., F. C. Mars, Pres., Minneapolis, Minn., has work under way on the construction of a candy factory at 2019 North Oak St., Chicago, Ill. Estimated cost $500,000. Austin Co., 510 North Dearborn St., Chicago, Ill., are engineers and contractors.

Candy Factory — Oswego Candy Works, 275 West First St., Oswego, N. Y., awarded contract for the construction of a 3 story addition to candy factory to Peter Raby Contracting Co., 3rd Ave., Oswego, N. Y. Estimated cost $75,000.

Cement Plant—Republic Portland Cement Co., J. H. Smith, Pres., San Antonio, Tex., plans the construction of a cement plant, 1,000,000 bbl. annual capacity. Estimated cost $2,500,000. Terrell Bartlett, Calcasieu Bldg., San Antonio, Tex., is engineer. R. K. Meade, 10 Chase St., Baltimore, Md., is consulting engineer. Contracts have been let for kilns, mills and coolers, also for the installation of all electrical equipment.

Cement Plant Addition—Canada Cement Co., E. French, Mgr., Hull, Que., plans addition to cement plant. Estimated cost $500,000.

Chemical Factory—W. Lynn Chemical Co., North Davidson St., Indianapolis, Ind., is having plans prepared for a 3 story, 35 x 100 ft. chemical factory. Estimated cost $65,000. L. H. Sturges, 527 Bd. of Trade Bldg., Indianapolis, Ind., is architect.

Chemical Plant—Floyd L. Carlisle & Co. 15 Broad St., New York, N. Y., is having preliminary plans prepared for the construction of a chemical plant at Oswego, N. Y. Estimated cost $500,000.

Chemical Plant Additions — Shawinigan Chemicals, Ltd., subsidiary of Shawinigan Water & Power Co., Shawinigan Falls, Que., is making extensive additions to plant in the way of new buildings and improved equipment including a rotary lime burning

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1913-14

This month	**113.02**
Last month	112.83
September, 1927	112.55
September, 1926	113.59

Strength in wood distillation chemicals and alcohol was largely responsible for the upward swing of the index number. Basic chemicals were generally steady. Among the coal-tars, phenol was noticeably lower.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1913-14

This month	**121.01**
Last month	120.61
September, 1927	134.48
September, 1926	154.26

Crude cottonseed oil and linseed oil were slightly lower for the month and vegetable oils in general showed an easy tone. Tallow and animal fats, however, were higher and strengthened the weighted index number.

plant with two rotary lime kilns, equipped with pulverized coal burning equipment and elevating and conveying machinery. $300,000, also new equipment for quarry at Bedford, Que. to consist of electrically driven crusher, screens, elevators and conveyors to provide 1,000 ton daily of crushed limestone to rotary lime kilns at Shawinigan Falls. $150,000.

Coke Screening Plant—Brooklyn Union Gas Co., 176 Remsen St., Brooklyn, N. Y., had plans prepared for a 42 x 104 ft. coke screeninig plant on Gardener Ave. Estimated cost $175,000. The Koppers Construction Co., Union Trust Bldg., Pittsburgh, Pa., is engineer.

Confectionery Factory—Euclid East 65th St. Co., I. W. Shenker, Secy. and Treas., Engineer Bldg., Cleveland, O., had plans prepared for a 4 story, 68 x 100 ft. factory. Estimated cost $80,000. Braverman & Havermalt, Ulmer Bldg., Cleveland, O., are architects. McNally-Doyle Co., (confectionery manufactures) East 65th St. and Euclid Ave., Cleveland, O., lessee.

Copper Factory—Tennessee Copper Corp., Skillman Rd., Cincinnati, O., awarded contract for a 1 story, 208 x 420 ft. copper factory to Ferro Construction Co., Elm St., Cincinnati. Estimated cost $500,000.

Cork and Seal Factory—Crown Cork & Seal Co., Highlandtown, Baltimore, Md., is having plans prepared for a 1 and 2 story, 150 x 600 ft. cork and seal factory. Lucius R. White, Hearst Tower, Baltimore, Md., is architect.

Cyanite Plant — Pollard Cyanite Co., Burnsville, N. C., plans construction of cyanite plant at or near Burnsville plant will produce 1000 ton of rock per day. J. A. Pollard, Mgr. Estimated cost $1,000,000.

Drug Factory — Park Davis Co., McDougal Ave., Detroit, Mich., awarded contract for a 6 story, 200 x 200 ft. factory on Joseph Campau Ave. to Otto Misch Co., 159 East Columbia St., Detroit, Mich. Estimated cost $600,000. Equipment for the manufacture of drugs will be installed.

Enameling Plant—Olds Motor Works, Division St., Lansing, Mich., awarded contract for a 1 story, 40 x 200 ft. building for enameling plant in connection with automobile plant to Reniger Construction Co., 127 North Cedar St., Lansing, Mich. Estimated cost $50,000.

Fertilizer Plant—Wilson & Toomer Fertilizer Co., 772 West Bay St., Jacksonville, Fla., plans addition to plant on Talleyrant Ave. Estimated cost $30,000.

Gas Compressor Station—Cities Service Gas Co., 60 Wall St., New York, N. Y., is receiving bids for the construction of a gas compressor station, 5,000 hp. capacity at Higgins, Tex. Estimated cost $100,000. Private plans.

Gypsum Deposits — Gulf Gypsum Co., Falfurrias, Tex., plans development of 870 acre tract containing gypsum deposits, plans the installation of Wallboard machinery to make building blocks.

Gypsum Plant—U. S. Gypsum Co., 1418 Penobscot Bldg., Detroit, Mich., awarded contract for a 1 and 2 story gypsum products factory at Davison Ave. and River Rouge to Morton C. Tuttle, 31 St. James Ave., Boston, Mass. Equipment arranged for by owners.

Laboratory—Brooklyn Union Gas Co., 176 Remsen St., Brooklyn, N. Y., plans the construction of a 35 x 75 ft. laboratory at Gardner Ave. and Withers St. Estimated cost $60,000. Bartlett-Hayward Co., 200 Scott St., Baltimore, Md., are engineers.

Laboratory—Dept. of Mental Hygiene, Capitol, Albany, N. Y., will soon award contract for the construction of a laboratory at Kings Park State Hospital, Kings Park, N. Y. W. Haugaard, 353 Broadway, Albany, N. Y., is architect.

Laboratory, Etc.—University of Maryland, Lombard and Greene Sts., Baltimore, Md., awarded contract for a 6 story, 166 x 195 ft. laboratory, etc. to Price Construction Co., Maryland Trust Bldg., Baltimore, Md.

Laboratory (Chemical)—E. F. Houghton Co., 240 West Somerset St., Philadelphia, Pa., will soon award contract for a 3 story, 30 x 60 ft. chemical laboratory at Third and Somerset Sts. Austin Co., 1015 Chestnut St., Philadelphia, Pa., is engineer.

Laboratory (Chemical) — Pennsylvania State College, State College, Pa., will receive bids until Sept. 20 for a 3 story, 45 x 134 ft. chemical laboratory. Estimated cost $175,000. C. Z. Keander, 1429 Walnut St., Philadelphia, Pa., is architect.

Laboratory (Chemical)—Royal Baking Powder Co., 100 East 42nd St., New York, N. Y., plans the construction of an 8 story addition to chemical laboratory at Kent Ave. and Maston St. Estimated cost $20,000. H. W. Paulus, 37-69 Ninth St., Brooklyn, N. Y., is architect.

Laboratory (Chemical)—Timken Roller Bearing Co., Dueber Ave. S. W., Canton, O., plans the construction of a 3 story administration building and chemical laboratory for steel mill on Harrison Ave. S. W. Estimated cost $50,000. R. T. Campbell and R. A. Zenk, 144 West Wood St., Youngstown, O., are architects.

Laboratory (Research)—Yale University, New Haven, Conn., plans the construction of a research laboratory. Estimated cost $150,000. C. A. Jackson, 463 8th Ave., New York, N. Y., is architect.

Laboratories (Chemistry and Physics)—North Carolina College for Negroes, Durham, N. C., plans the construction of a 3 story, 60 x 150 ft. college including chemistry and physics laboratories on Fayetteville St. Estimated cost $150,000. Atwood & Nash, Durham, N. C., are architects.

Laboratories (Physic and Chemistry)—Bd. of Education, A. K. Bunnell, Secy., Brantford, Ont., will soon award contract for a 3 story, 75 x 120 ft. technical school including physics and chemistry laboratories., etc. on Brant Ave. Estimated cost $185,000. F. C. Bodley, Temple Bldg., Brantford, Ont., is architect.

Laboratories (Research) — American Potash & Chemical Co., Trona, Calif., is having plans prepared for a 2 story, 50 x 170 ft. research laboratories and offices, etc. Parkingson & Parkinson, Title Insurance Bldg., Los Angeles, Calif., are architects.

Leather Factory—C. K. Cook Co., 211 South Second St., Camden, N. J., awarded contract for a 3 story, 52 x 150 and 50 x 120 ft. addition to leather factory at Second and Mickle Sts. to H. J. Homan, 18th and Cherry Sts., Philadelphia, Pa. Estimated cost $80,000.

Leather Factory—Park Leather Co., 55 Grove St., Salem, Mass., will soon award contract for a 2 story, 35 x 72 ft. leather factory on Grove St. Estimated cost $40,000. W. H. Hunt & Son, 208 Essex St., Salem, Mass., are architects.

Match Factory—T. A. Box, et al., 63 Sunshine St., Sausalito, Calif., plans the construction of a match factory at Redwood City, Calif. Estimated cost $500,000.

Metal Mill—Western Electric Co., 195 Broadway, New York, N. Y., is having plans prepared for the construction of a non-ferrous metal mill at Cicero, Ill. Estimated cost $3,000,000. Private plans.

Milk Condensery—Page Milk Co., R. B. Page, Pres., Merrill, Wis., awarded contract for a 2 story milk condensery on West 8th St. to Universal Construction Co., Coffeyville, Kan. Estimated cost $100,000.

Mixing Bins—Brooklyn Union Gas Co., 176 Remsen St., Brooklyn, N. Y., plans 3 story, 32 x 94 ft. mixing bins at Garden and Maspeth Aves. Estimated cost $130,000. The Koppers Construction Co., Union Trust Bldg., Pittsburgh, Pa., is engineer.

Oil and Gas Refinery—J. J. & M. Taxman, Wichita Falls, Tex., have acquired the plant of the Miller Refining Co. and plans extensions and improvements. Estimated cost $50,000. Private plans. Machinery and equipment will be required.

Oil Refinery—Homokle Oil Co., Allen, Okla., awarded contract for the construction of a new oil refinery to Graver Corp., 4809 Todd Ave., East Chicago, Ind. Estimated cost $125,000.

Paint and Glass Factory—Mautz Paint & Glass Co., Madison, Wis., will soon award contract for a 3 story, 60 x 150 ft. factory Estimated cost $80,000. Law, Law & Potter, Madison, Wis., are architects.

Paint and Glass Factory—Perry Paint & Glass Co., Tampa, Fla., awarded contract for the construction of a 5 story paint and glass factory near Washington St. to Logan Bros., Tampa, Fla. Estimated cost $65,000.

Paint Factory and Warehouse—Con-Ferro Paint & Varnish Co., I. Koplar, Secy., 118 South Main St., St. Louis, Mo., awarded contract for a 1 story, 60 x 100 and 40 x 200 ft. factory and warehouse at 3200 North Broadway to N. M. Kaplan, 806 Chestnut St., St. Louis, Mo. Estimated cost $100,000.

Paper Mill—Mersey Paper Co. Ltd., C. H. L. Jones, Pres., Halifax, N. S., plans the construction of a paper mill on Mersey River in Queens county. Estimated cost $5,000,000.

Paper Manufacturing Plant, Etc.—Zellerbach Paper Co., 1213 Front St., Sacramento, Calif., awarded contract for a 4 story, 50 x 125 ft. paper manufacturing plant, warehouse, printing plant, etc. to replace plant destroyed by fire, to Campbell Construction Co., 800 R. St., Sacramento, Calif. Estimated cost $160,000.

Paper Mill—Pacific Coast Paper Co., Richvale, Calif., awarded contract for a group of buildings for paper mill for the manufacture of paper products from rice straw and rice mill waste, to Thomas B. Hunt, 1510 30th St., Sacramento, Calif. Estimated cost $1,000,000.

Paperboard Mill Addition — Hinde & Dauche Paper Co. of Canada, 43 Hanna St., Toronto, Ont., plans the construction of a 1 and 2 story addition to paperboard mill. Estimated cost $500,000. R. Cook, 43 Hanna St., Toronto, Ont., is engineer. Equipment including paper mill equipment, beaters, shafting, electric motors, paper machine, pumps, screens, etc. will be required.

Porcelain Factory — City Commission, Trenton, N. J., announces that a new porcelain factory will be constructed, here. Name of owners withheld. Estimated cost $50,000.

Pulp and Paper Mill—Pacific Coast Pulp and Paper Co., Richvale, Calif., awarded contract for a group of 1, 2 and 3 story buildings for pulp and paper mill to T. B. Hunt, 1510 30th St., Sacramento, Calif. Estimated cost $1,000,000.

Rayon Factory—New Bedford Rayon Co., Manoment Mills Plant, New Bedford, Mass., awarded contract for reconstruction and alterations to rayon factory on Belleveille Ave. to Loche & Thomas, Olympia Bldg., New Bedford, Mass. Estimated cost $40,000. Machinery and equipment will be installed.

Rayon Manufacturing Plant—E. I. Du Pont de Nemours & Co., Wilmington, Del., plans to expend $46,000,000 for construction and equipment of a rayon manufacturing plant, comprising eight units at Waynesboro, Va.

Refinery—Roxana Refinery, Arkansas City, Kan., plans two additional units to refinery. Estimated cost $500,000. Work will be done by day labor.

Refinery (Oil)—Swift & Co., 916 East-First St., Los Angeles, Calif., awarded contract for a 2 and 4 story, 115 x 215 ft. oil refinery at Vernon, Calif. To Richards-Neustadt Construction Co., National City Bank Bldg., Los Angeles, Calif. Estimated cost $135,000.

Refinery (Oil) — Swift & Co., 916 East Co., Central Savings & Trust Bldg., Akron, O., awarded contract for a 9 story, 148 x 260 ft. warehouse for rubber factory, to Carmichael Construction Co., South Main St., Akron, O. Estimated cost $1,000,000.

Rubber Factory—Goodyear Tire & Rubber Co., East 21st and Chester Sts., Cleveland, O., plans the construction of a 4 story, 100 x 300 ft. addition to rubber factory at New Toronto, Ont. Equipment will be required.

Rubber Factory—Northern Rubber Co. Ltd, Metcalfe St., Guelph, Ont., is having plans prepared for a 2 story, 60 x 120 ft. addition to rubber factory. Estimated cost $80,000. James, Proctor & Redfern, 36 Toronto, St., Toronto, Ont., are engineers.

Rubber Factory—Panco Rubber Co., F. Bernstein, Pres., 31 Highland St., Chelsea, Mass., will soon award contract for a 2 story, 90 x 100 ft. addition to factory. Schein & Levine, 448 Broadway, Chelsea, Mass., are architects.

Rubber Factory—Selberling Rubber Co., 60 Federal St., San Francisco, Calif., plans the construction of a rubber factory. Estimated cost $40,000.

Rubber Products Factory—Ban Rubber Products Co., Sandusky, O., plans to rebuild rubber products factory recently detroyed by fire. Estimated cost $50,000.

Sulphuric Acid Plant—Davison Chemical Co., Garrett Bldg., Baltimore, Md., plans an addition to sulphuric acid plant to double present capacity of 100 ton per day.

Tile Factory—Buckeye Tile Co., Chillicothe, O., plans the construction of a 1 story, 104 x 200 ft. tile factory. Estimated cost $40,000.

Tile Manufacturing Plant—American Encaustic Tiling Co., Maurer, N. J., awarded contract for a 2 story, 60 x 100 ft. tile manufacturing plant on State St., Perth Amboy, N. J., to The Austin Co., 120 Broadway, New York, N. Y. Estimated cost $40,000.

Tile Roofing Factory—California Spanish Tile Roofing Co., Culver City, Calif., is having plans prepared for a 1 story, 65 x 156 ft. factory on Elenda St. A. B. Sturges, 4354 West Third St., Los Angeles, Calif., is architect.

Zinc Mill—Empire Zinc Co., Gilman, Colo., is having plans prepared for the construction of a zinc flotation mill, 600 ton daily capacity.

Zinc Smelter—National Zinc Co., Dewey, Okla., had preliminary plans prepared for the construction of a new zinc smelter at Dewey, Okla. Estimated cost $60,000. Private plans.